

# STORY *of the* GRAND CANYON *of* ARIZONA

A POPULAR ILLUSTRATED  
ACCOUNT OF ITS  
ROCKS AND ORIGIN  
BY N.H. DARTON, GEOLOGIST  
U. S. GEOLOGICAL SURVEY

*Published by*  
FRED HARVEY















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*A Popular Illustrated Account*  
*of Its Rocks and Origin*

By N. H. DARTON, Geologist  
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NINTH EDITION  
REVISED AND ENLARGED

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FRED HARVEY,  
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ZOROASTER FROM THE RIVER



## P R E F A C E

**T**HE GRAND CANYON OF ARIZONA—a titanic gash in the face of the earth, 217 miles long, 8 to 20 miles wide and more than a mile deep—was first discovered by Spaniards in 1540. It was next seen by Spanish priests in 1776. Then for more than eighty years the great chasm was unvisited except by Indians, pioneer herdsmen and trappers.

In 1857, an Army expedition under Lieutenant Ives ascended the Colorado River to the head of navigation; but it remained for John Wesley Powell, a school teacher, geologist and one-armed veteran of the Civil War (who afterwards became Director of the United States Geological Survey), to dare and accomplish the exploration of the mighty river.

With nine men and four boats, Major Powell started from Green River City, Utah, May 24, 1869. Over three months later he landed at the mouth of the Virgin River, more than a thousand miles from the starting point, minus two boats and four men. The trip was hazardous in the extreme. The adventurers faced the unknown at every bend, and their little boats were constantly upset.

Powell's later explorations over a long period of years gave to the world much information concerning both the geologic and scenic features of the Canyon. Many scientific expeditions have since visited it, but Powell easily ranks at the top of the list of Grand Canyon explorers. The journal of his first voyage is a most fascinating tale, which, despite its modest style and reticence, tells an epic story of American heroism.



**T**HE GRAND CANYON is one of the wonders of the world, but the story of its origin is as simple as any that Nature offers—The result of a process which can be observed in the most ordinary gulley beside a country road.

Water has been the principal agent in the making of the great gorge—water falling as rain in or near the Canyon and washing away its walls; water journeying to the sea as the Colorado River, slowly carrying away its rocky banks. Frost, heat and cold have aided in expanding and contracting the rocks, while wind-blown sand has slowly torn away the rock surfaces.

The activity of these forces in wearing away the surfaces of land forms is called “erosion.” It is a slow but unending process. Probably in a century the effect of all the cutting might seem insignificant, but in the thousands of centuries that it has been in progress, great results have been accomplished. Time is the all-important element.

In this popular account, Professor Darton explains how these forces worked together in the making of the Grand Canyon. He describes the various rock formations found in different portions of the chasm and the interesting features that may be seen from the several points.

The process of erosion continues its slow but unceasing work. The Colorado River below El Tovar is still nearly 2,400 feet above sea level, and the deepening and widening of the gorge will continue through the ages.

So the Story of the Grand Canyon is by no means finished!

THE PUBLISHERS.



## CONTENTS

| CHAPTER   | PAGE |
|---|------|
| PREFACE .....                                       | 3    |
| INTRODUCTION .....                                  | 6    |
| I. THE ORIGIN OF THE GRAND CANYON...                | 7    |
| II. THE ROCKS. . . . .                              | 11   |
| III. THE HISTORY OF THE ROCKS.....                  | 16   |
| IV. THE CANYON FROM EL TOVAR.....                   | 21   |
| V. FROM HOPI POINT.....                             | 30   |
| VI. YAVAPAI POINT. . . . .                          | 39   |
| VII. BRIGHT ANGEL TRAIL.....                        | 45   |
| VIII. GRAND VIEW POINT.....                         | 51   |
| IX. HERMIT TRAIL. . . . .                           | 60   |
| X. THE VIEW FROM POINTS FAR TO THE<br>WEST. . . . . | 62   |
| XI. THE NORTH RIM.....                              | 63   |
| XII. DESERT VIEW. . . . .                           | 65   |
| XIII. LIPAN POINT .....                             | 70   |
| XIV. BRIGHT ANGEL CANYON.....                       | 71   |
| GEOLOGICAL MAPS .....                               | 77   |



## INTRODUCTORY

**T**HE GRAND CANYON is the most instructive exposition of geology in the world, particularly as many of its features can be understood by persons not familiar with the science. It exhibits thick succession of rocks of various kinds and ages, some of them tilted at different angles, and it illustrates most clearly, on a titanic scale, the origin of many types of land forms.

The purpose of this guide is to point out the more important relations of the rocks and to outline their history and the conditions under which the canyon was developed. Care has been taken to avoid technical terms as far as possible so that most persons should have no difficulty in understanding every part. The maps, cross sections and lettered views will aid greatly in connecting the descriptions with the objects themselves.

There is slight repetition in the detailed descriptions for the same objects are visible from various viewpoints and it seemed better to repeat some of the statements under each heading than to suppose that the reader would carry all the facts in mind.

N. H. DARTON.



## THE ORIGIN *of the* GRAND CANYON

The Grand Canyon is a rock-walled, steep-sided valley, more than a mile deep, which crosses the high plateau of northern Arizona. Through its bottom flows the Colorado, one of the great rivers of North America, which rises in the Rocky Mountains in Colorado and Wyoming and empties into the Gulf of California. The average width of the canyon is eight miles, but portions are wider. Its sides are a succession of rocky slopes and sinuous cliffs, some of which are huge steps with a sheer descent of 300 to 500 feet.

The Colorado River in the Grand Canyon averages about 300 feet wide, 30 feet deep, and, with a mean velocity of about two miles an hour, has a volume of 20,000 cubic feet a second, at times of ordinary flow. At times of flood, which are not infrequent, the depth is more than twice as great and the velocity and volume are greatly increased. The river falls about 600 feet in its passage through 50 miles of the central part of the canyon, or 12 feet to the mile. At all times the water is muddy with sediment and the floods not only carry a great volume of sand and gravel but move boulders and rock masses down stream. Whenever there is rain the many side streams discharge into the river a greater or less amount of debris gathered from the side slopes of the canyon. The great river eventually carries all this material through the canyon and out into the flat country or to tidewater, far to the southwest.

"How was it formed?" is one of the very first questions which come into the mind of a person looking at the stupendous chasm.

Geologists are agreed that there is but one explanation; it has been excavated by the river and its branches working for many, many years. The process is called erosion. The work began when the plateau surface was a continuous plain. It has continued for many years and is still in vigorous operation. The deepening and widen-



ing will continue to progress for the gorge must be more than two thousand feet deeper than it now is before the great river reaches sea level, or a grade so low that the debris could no longer be moved.

An important agent in the development of the canyon has been a gradual uplift of the whole plateau country, which has maintained the steep downgrade of the river. The cutting of canyons and valleys by running water is a very common action, in progress everywhere, but the Grand Canyon is probably the most impressive and picturesque example of it in the world. The principal cause is the fact that running water carries sand in suspension and this water-borne sand cuts rocks, whether hard or soft, tearing off grains and small fragments which are carried down stream by the water. The amounts depend mainly upon the velocity and volume of the stream, but the process is unending.

This action takes place not only along the great river, which in reality cuts merely along the narrow zone of its own immediate vicinity, but in every rivulet and branch creek, whether they flow for a long or short time, and the load travels as far downgrade as conditions permit. Eventually, it reaches the river in the form of sand, silt or boulders and the Colorado then carries it along through and out of the canyon.

There is also much undermining of the ledges by solution of the limestone by rain water, and as this process progresses, great blocks fall on the slopes below, there to disintegrate into smaller masses. Other important agencies of erosion are frost and the changes of temperature that expand and contract the rock. Both of these cause cracks and fissures along which fragments break off and new surfaces are exposed. Sand of disintegration is blown away by the wind and, in its movement, carves all the surfaces, carrying away an additional body of sand to grind other surfaces. In the canyon most of the wind-blown material goes downward, or lodges on slopes from which it is finally washed down to the river. The agencies of solution of limestone—frost, temperature changes and wind-blown sand aid greatly not only in





THE COLORADO RIVER AT THE FOOT OF BRIGHT ANGEL TRAIL

developing the cliffs, but in cutting them back and carving them into fantastic forms.

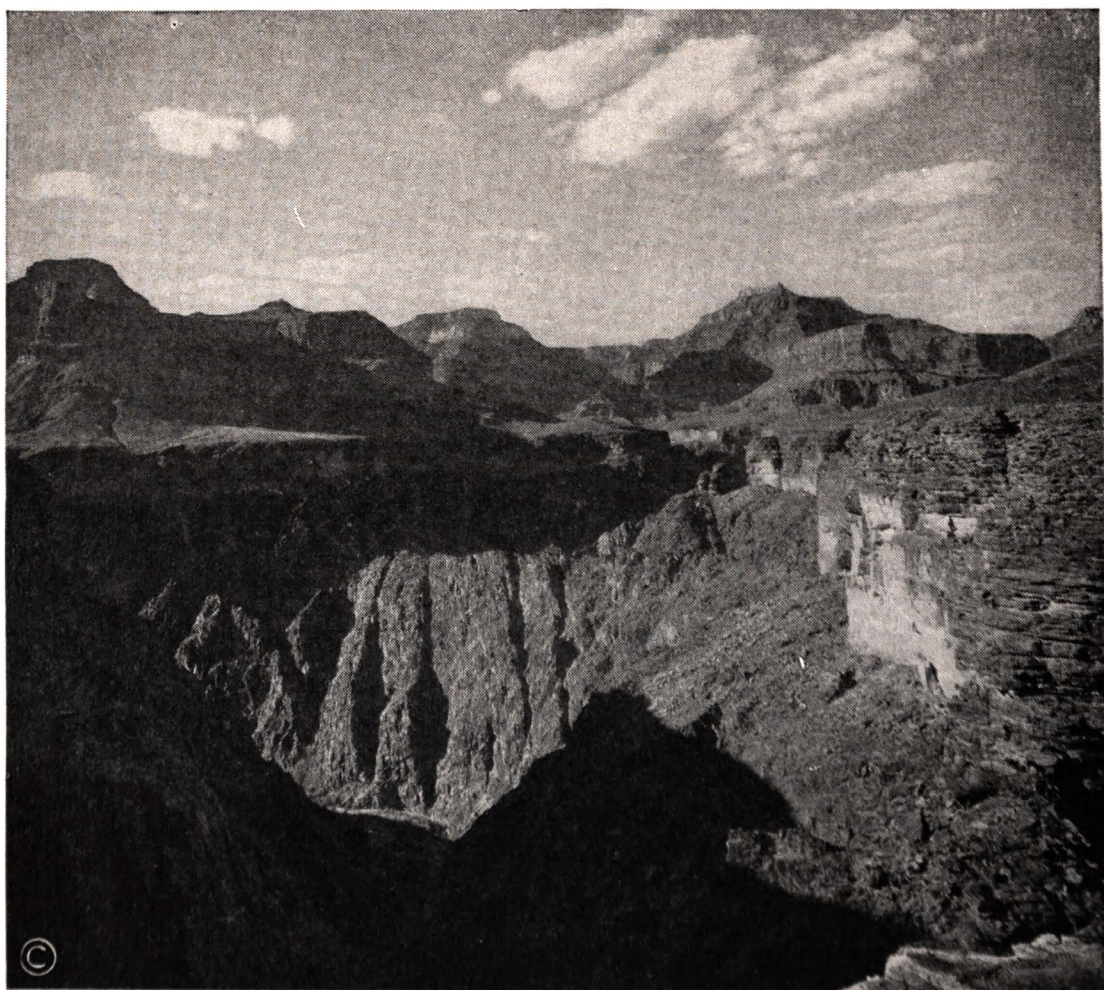
Great as has been the work of erosion in excavating the Grand Canyon, it is all a very recent event, geologically, and a small achievement as compared with the vast removals here of land surfaces to great depth by running water in previous times. The canyon has simply been



## 10 STORY OF THE GRAND CANYON OF ARIZONA

cut down and down as the land rose and all the declivities have been and are so steep that the detritus is carried away with great rapidity. This canyon-cutting becomes insignificant when compared with the previous planation of the great "granite" surface and still later land masses which are now far down in the canyon and deeply buried by much younger rocks.

These old surfaces originally were regions of rugged mountains which were mostly leveled before the next geologic formation was laid down upon it. Likewise, a long time later a great series of formations above the present plateau surface was removed. This required continued action of the elements for many thousands of centuries, yet all of it was done before the excavation of the Grand Canyon was begun.



SUNSET IN THE GRANITE GORGE



## THE ROCKS

Looking along the canyon walls from all points of view one can readily see that for a great depth these walls expose the edges of a succession of thick layers or "formations" lying nearly horizontal, and that each "formation" is uniform in thickness and character as far as the eye can reach. These formations present marked differences in character, some of them being red, others gray or green, and while the hard beds rise to great cliffs, the softer ones break into slopes. The succession of formations in the walls is shown in the various figures and views in this book. At the top is the great forest-covered plateau which at the edge of the canyon terminates in cliffs of light-gray, slabby limestone. This has been named Kaibab limestone from the great plateau which it constitutes on the north side of the canyon; it also constitutes the Coconino Plateau of the south rim. This limestone formation is nearly 800 feet thick and while nearly uniform in character from top to bottom, contains harder and softer beds and many layers of flint. Casts of fossil shells abound in some layers.

Under the Kaibab limestone is the 300-foot bed of gray sandstone known as the Coconino and so named from the great plateau which it underlies for many thousand square miles. It appears everywhere in the canyon walls as a vertical cliff of gray color 800 feet below the top and easily recognizable all along both sides. On close view it is seen to be very massive and strongly cross-bedded, that is, made up of irregular layers of sand sloping in many different directions. Next below the Coconino sandstone, is a series of red shales and red sandstones, about 1,100 feet in all. This formation is named Supai because it is the wall of the portion of Cataract Canyon where the Supai Indians live. It consists of alternations of bodies of red shale and thick ledges of red and red-brown sandstones. The latter are hard and cause a great succession of steps in the red middle slopes along both sides of the canyon. These red rocks constitute a





CLIFF DWELLINGS IN GRAND CANYON

large part of many fine promontories and ridges projecting far out into the canyon. Such features as O'Neill Butte, Newton Butte, Tower of Set, Tower of Ra, Geikie Peak, Dana Butte, Horus Temple, Sagittarius Ridge, Krishna Shrine, Rama Shrine, Isis Temple, Venus Temple, Apollo Temple and Lyell Butte, consist of the Supai formation. It also constitutes the great red steps of the middle slopes of the gigantic ridges of Shiva Temple, Wotan's Throne, Brahma Temple, Osiris Temple, Zoroaster Temple, Vishnu Temple and other prominent features.

Everywhere below these red beds is a great wall due to the Redwall limestone, a massive body of hard compact limestone about 500 feet thick. It is pale blue-gray when fresh or broken, but most of the cliffs are stained red by wash from the overlying red beds. This stain gives the surface of the rock a very misleading reddish appearance, from which the name Redwall originated. The great



cliff of this limestone is a very conspicuous feature throughout the canyon and always appears in regular order in the succession of formations. It also constitutes many long flat-topped spurs and buttresses extending out from the Supai-capped promontories, and outlying masses of the Redwall limestone isolated by erosion are seen in Cheops Temple, Newberry Butte, Sheba Temple, Solomon Temple and many other flat-topped mesas and buttes. The top of the limestone ledge is marked by a narrow bench at the foot of the Supai slope, and in many places the cliff shows deep alcoves or recesses with overhanging roof.

The Redwall and overlying rocks (Supai, Coconino, and Kaibab) are all members of the Carboniferous period of time in which the great older coal deposits were accumulated in various parts of the world. The Tonto group below the Redwall consists of shale mainly of



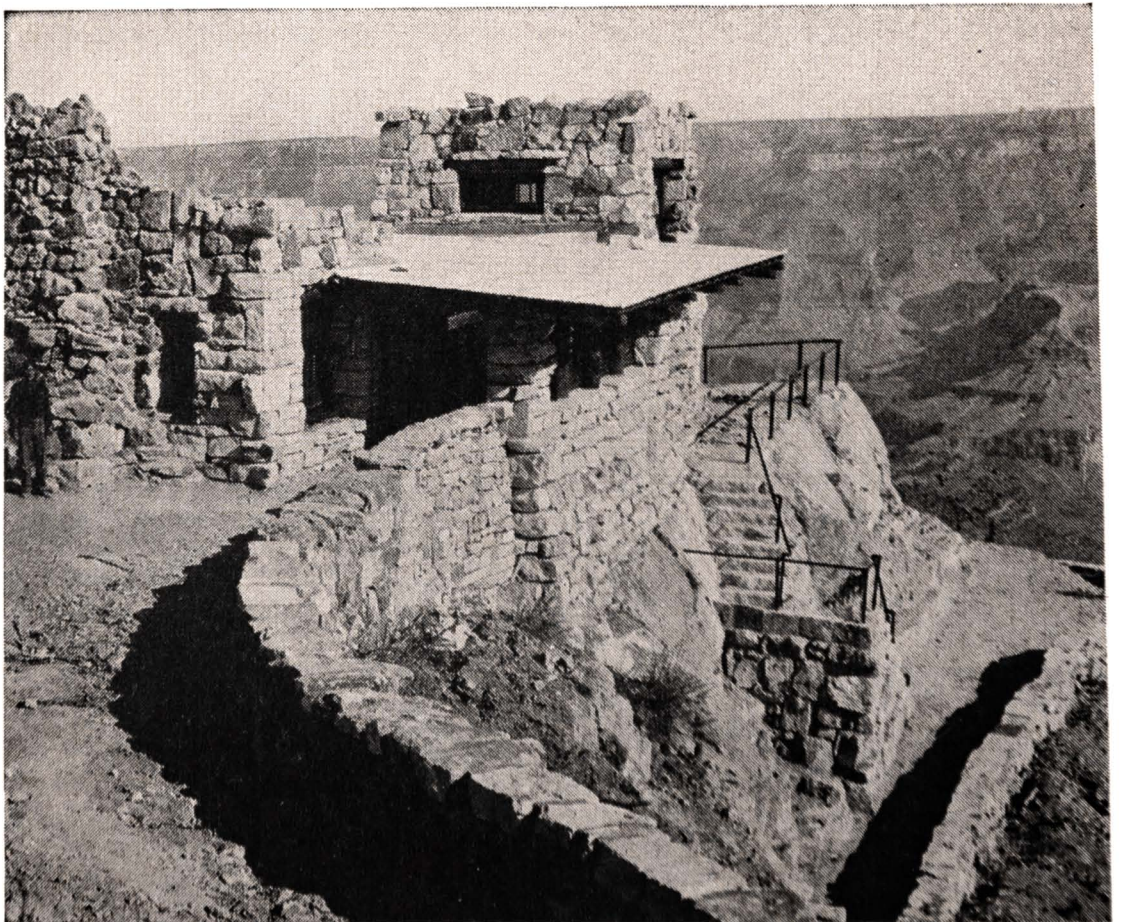
IN CATARACT CANYON



## 14 STORY OF THE GRAND CANYON OF ARIZONA

greenish color and about 800 feet thick, and a basal formation of sandstone averaging 150 feet thick. This group is very much older than the Redwall limestone and while the beds are practically parallel at their contact there is hiatus between them covering a very considerable portion of geologic time, represented by many thousands of feet of rocks in other portions of North America.

For many miles this shelf of sandstone of the Tonto is cut through by the steep inner gorge which descends to the river, 800 to 1,000 feet below, and shows the underlying granite in precipitous, dark, rugged ledges. This granite is part of the very old earth crust. In a wide area the basal sandstone of the Tonto lies directly on its smoothed-off surface, but in other places, notably in the board part of the canyon northeast of Grand View, in Shinumo basin, in part of Bright Angel Canyon, and the ridges extending northwest and southeast from near the mouth of Bright Angel Creek, and in Ottoman and Hindu



THE LOOKOUT



amphitheatres; other rocks remain between the granite and the Tonto. These are known as the Grand Canyon Series, comprising the Unkar and Chuar groups, all named from localities where they are well exposed. Their beds are considerably tilted. Their surface was worn to a rolling plain in early geologic time and on this the shales of the Tonto group lie nearly horizontal. The Unkar group, which is the one exposed from most points of view, consists of a succession of basal conglomerate, limestone in thick dark beds, bright red shales, and upper heavy quartzites and brown sandstones.<sup>1</sup> This succession of rocks is plainly visible in Bright Angel Canyon and the ridges culminating in Cheops Pyramids, also along the river looking northeast from Grand View Point. The overlying Chuar rocks are extensively exposed in the region west and northwest of the mouth of Little Colorado River. These Unkar and Chuar beds slope rather steeply to the north and northeast in marked contrast to the nearly horizontal bedding of the Tonto and overlying rocks, and have a total thickness of 12,000 feet.

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<sup>1</sup> These rocks have been named Hetauta conglomerate, Bass limestone, Hakatai shale, Shinumo quartzite, and Dox sandstone.



NORTHWEST FROM MOHAVE POINT



## THE HISTORY OF THE ROCKS

The geological history recorded by the rocks exposed in the Grand Canyon covers a large part of geologic time and many of their features indicate the land and water conditions that prevailed during various periods.

The granite and gneiss exposed in the lower gorge is part of the original earth crust dating back to a time when the cooling-off process was far from complete. It was subjected to great heat and pressure, twisting and upturning. It belongs to the oldest system known to

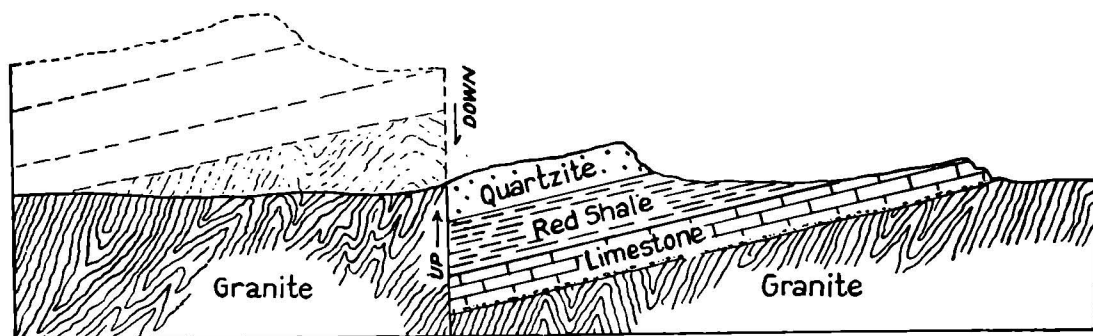


FIGURE 1

Ideal section of faulted block of Unkar rocks in the Grand Canyon (upper part of uplifted block since eroded away, shown by broken lines).

geologists.<sup>2</sup> The great series of limestones, sandstones and red shales and other rocks of the Unkar and Chuar groups which lie on the "granite" in portions of the area are considerably younger but still represent one of the oldest periods of geologic time (the Algonkian). Prior to the deposition of these materials the old "granite" ledges had been eroded by streams to a relatively smooth

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<sup>2</sup> For the purpose of classifying rocks, geologists have divided the many millions of years of the past, into 12 periods, each with a special name. Four of these periods are represented by the rocks of the Grand Canyon. The first, Archean, or the time of the earliest known earth crust; the second, Algonkian, named from the region about the Great Lakes occupied by the Indians of that name; the third, Cambrian, named after the Cambrian hills of England where rocks of this early period were first recognized; and the seventh, Carboniferous, referring to the rocks of the great early coal age, the coal consisting largely of carbon. Rocks of the fourth, fifth, sixth, eighth and later periods are absent.



surface as indicated by the fact that the conglomerate at the base of the Unkar group lies on a nearly level plain.

A long period of time was required for the deposition of the Unkar and Chuar beds, which were laid down partly in the sea and partly on beaches and along streams and estuaries to a thickness of many thousand feet on the granite surface. Then followed widespread uplift of the land causing the wearing away of the deposits by running water. There was also extensive tilting of the beds and faulting or breaking of the earth's crust, by which huge wedge-shaped masses of the Unkar and Chuar beds were broken apart. In these faults, or breaks, the rocks on the uplifted side were eroded away in large part, leaving the granite bare again while those on the dropped side remained, and it is principally the latter that we now find occurring in the canyon area. An outline of these conditions is shown in figures 1 and 2.

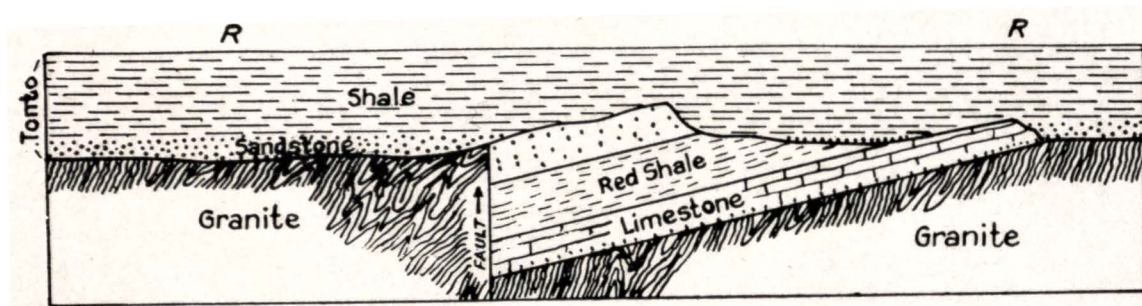


FIGURE 2

Showing Tonto Group deposited over the eroded surface of Unkar rocks and "Granite."

At the beginning of the time when the sandstone at the base of the next group (Tonto) was deposited, the smoothed off "granite" surface was submerged but some of the Unkar and Chuar rocks rose above the waters as hilly islands. This is shown by the heavy line in Figure 2. Against the shore of these islands and out over the submerged "granite" plain the sand of the basal Tonto was deposited to a thickness of from 100 to 200 feet. Then with deepening water the muds now represented by 600 or 700 feet of the green shale, accumulated, finally burying the Unkar islands below several hundred feet of material. The remains of life (shells, etc.) in these Tonto beds indicate that they represent a portion of Cambrian time.



## 18 STORY OF THE GRAND CANYON OF ARIZONA

The conditions during the next three long and very important geologic periods are not known, for their representatives are absent except small remnants of limestone of Devonian age. The sea may have laid down here deposits of great thickness which were later uplifted into land areas that were removed by streams and other agents of erosion.

In early Carboniferous time, or the period of the accumulation of the older great coal-bearing deposits in other places, the entire region was deeply submerged by the sea which deposited calcium carbonate in nearly pure condition, now represented by 500 feet or more of the Redwall limestone. This was succeeded, probably gradually, by shallow water conditions in which the red muds and sands now represented by the Supai formation were laid down to a thickness of a thousand feet or more. Where these sediments came from and the conditions under which they were deposited, are not known, but



HAVASUPAI POINT



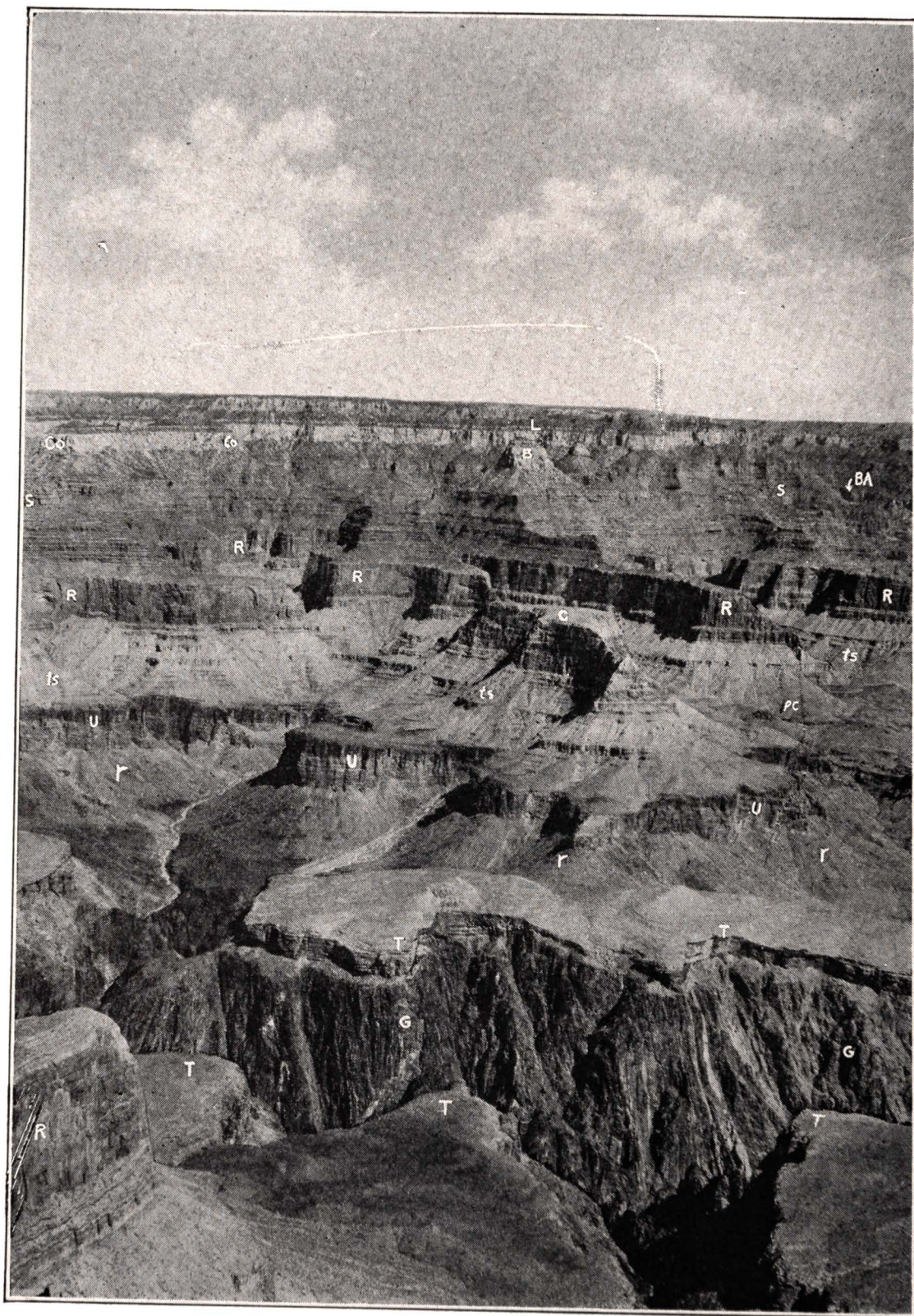
undoubtedly they were derived from land surfaces not far away where granite, limestone and other rocks were decomposing and yielding red muddy sediments to streams flowing out across the area of Supai deposition.

The change to Coconino deposition was a very decided one, for this coarse gray sandstone usually lies abruptly on the soft red shale at the contact of the two formations. The sand of which it is formed was laid down on beaches and in places where there were strong currents, for the grains are clean and light colored and the extensive cross-bedding indicates that there were vigorous currents in various directions. Such a deposit is usually accumulated rapidly, so probably the 300 feet of sand represents a relatively short space of geologic time.

This epoch was terminated abruptly by deeper submergence due to a long continued subsidence of the land. An extensive sea laid down a thick deposit of calcium carbonate now represented by the Kaibab limestone. The numerous shells in this deposit are the sort that lived in the sea. The water probably was moderately deep and it is believed that the limy sediments accumulated very slowly during a period of gradual subsidence. The time required for the deposition of 700 feet of sediments of this sort must have been very great and have continued for a large part, if not entirely through the later part of the Carboniferous period.

Upon the Kaibab limestone, which now constitutes the present surface of the high plateau, there were deposited many thousands of feet of sandstone and other rocks through a very long part of geologic time. These rocks originally covered the present plateau area but were removed by erosion in greater part, before the excavation of the canyon. Remnants of them may be seen in Red Butte not far south of El Tovar, in Cedar Mountain, to the eastward on the Coconino Plateau, and in the great line of cliffs far to the north beyond Kaibab Plateau. Their removal required millions of years.





### NORTH SIDE OF GRAND CANYON, OPPOSITE EL TOVAR

At the top is Kaibab Plateau capped by Kaibab Limestone. B—Buddha Temple (Kaibab Cap), S—Red Beds of Supai Formation, R—Redwall Limestone which caps Cheops Temple C, etc. TS—Shale of Tonto Group, S—Tonto Plateau (Sandstone), U—Dark Quartzite of Unkar Group, r—Red Shale of Unkar Group, G—Granite, BA—Bright Angel Canyon, Co—Coconino Sandstone, PC—Phantom Creek Canyon, 1,200 feet below. Colorado River is about 800 feet below GG.



## FROM EL TOVAR

The hotel at Grand Canyon is built upon the edge of the great plateau up which the traveler has gradually ascended all the way from Williams. At this edge there are huge step-like cliffs descending into one of the most interesting and picturesque alcoves of the south wall. It is the valley of Garden Creek. The views from the rim immediately in front of the hotel afford a good general insight into the character of the canyon, for the vista extends across the great chasm to the north rim eight miles away and for some distance up and down its course. This view has enraptured all who have had the privilege of seeing it. Owing, however, to the projecting points, Hopi on the left and Yavapai on the right, the outlook up and down the canyon is somewhat restricted. Therefore it is advisable to go out on these points for views of wider range.



EL TOVAR HOTEL ON THE RIM



## 22 STORY OF THE GRAND CANYON OF ARIZONA

Many superb features are in full view from the parapet in front of the hotel, and some of the details can be studied to great advantage through the telescopes provided for the use of visitors.

As one stands on the parapet he is on the edge of the first big drop into the canyon over the cliffs of Kaibab limestone forming the crest of the rim, and leading to the precipice of Coconino sandstone 700 feet below. This precipice, 300 feet high, is a marked feature all along the canyon on both walls, as a horizontal gray bank of great



VIEWING THE CANYON THROUGH TELESCOPE IN THE LOOKOUT

distinctness. Below this precipice are the steep slopes and numerous minor cliffs of bright red rocks which constitute many of the great ridges and promontories that jut far out into the canyon, in most cases rising into wonderful pinnacles and buttes of many forms. This is the Supai formation, 1,100 feet thick. These red rocks are conspicuous in the "Battleship," a turreted mass slightly to the left. At every place they extend down to a great wall-making ledge of limestone 500 feet thick, known as the Redwall because it is stained red by the wash from



the red rocks above. This gigantic cliff is prominent in every direction and at many points in the view it will be seen to form a broad projecting shelf or promontory extending out from the base of the Supai ridges.

One notable exposition of the Redwall limestone is the tabular mass of it known as Cheops Pyramid, straight across the canyon but not far above the rim of the inner gorge. This mass was formerly continuous with the ledge which extend under the great ridge a short distance to the left, culminating in Isis Temple.

Below this imposing limestone cliff there is everywhere in the canyon a long slope of greenish color, of the shales of the Tonto group. These are about 800 feet thick. This slope leads down to the Tonto Platform, a wide shelf far down in the canyon and very distinctly recognizable from nearly every point of view. This platform consists of a thick sheet of coarse sandstone forming the base of the Tonto group. The shelf extends along both sides of the canyon for many miles, varying in



READY FOR A RIDE THROUGH THE FOREST

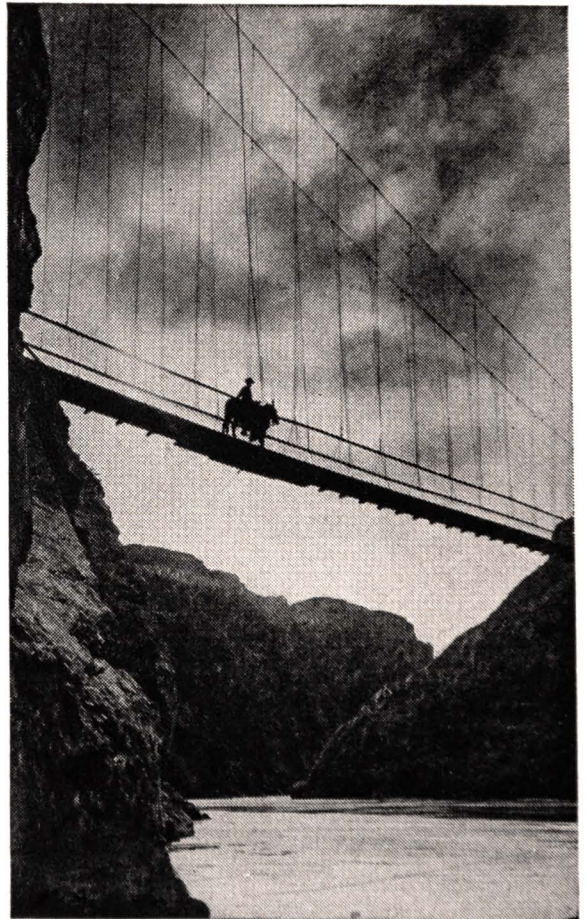


## 24 STORY OF THE GRAND CANYON OF ARIZONA

width from a few hundred yards to nearly a mile. Trails run along it by which one can travel eastward to beyond Grand View and westward to Hermit Basin and far beyond. There are numerous springs coming out of this sandstone of the Tonto group at various places, which are most useful to those who travel along the trail.

Around one of these are the Indian Gardens, far beneath the parapet at El Tovar. Here the water is used for irrigation and long before the white man came, the Indians found a little oasis here with water which they utilized for irrigation. Bright Angel Trail can be seen winding its way through this place and out onto the Tonto Platform.

It will be noted that all these rocks down to this sandstone of the Tonto are in thick beds or layers lying horizontal, and the same succession is present in every direction making due allowance for differences in heights, and for perspective. Looking over the Tonto Platform one may see far into the narrow granite gorge. It is 1,200 feet deep at this place. Here the river make a big S-shaped turn in its course.



KAIBAB SUSPENSION BRIDGE  
OVER COLORADO RIVER

On the opposite side of the gorge towards Cheops Pyramid and on either side for some distance, will be noted some red shales with cliffs of dark hard rocks above and below. These are rocks of the Unkar group and their beds slope toward the north at a moderate angle. This Unkar area is a remnant of an old land surface that rose



as an island from the waters that deposited the Tonto sediments around it; finally as the water deepened it was covered by the shale of the Tonto group, as shown in Figure 2. The succession of rocks at El Tovar and northward is shown in some of the following figures.

One of the most conspicuous features in the view from the vicinity of the hotels is the long straight canyon of Bright Angel Creek. It cuts deeply into the wall on the opposite side of the canyon, making a recess extending back 10 miles from the river. It holds Bright Angel Creek which rises high up in the Kaibab Plateau to the north, cuts through the great succession of horizontal rocks, and finally flows in a deep gorge in the granite to

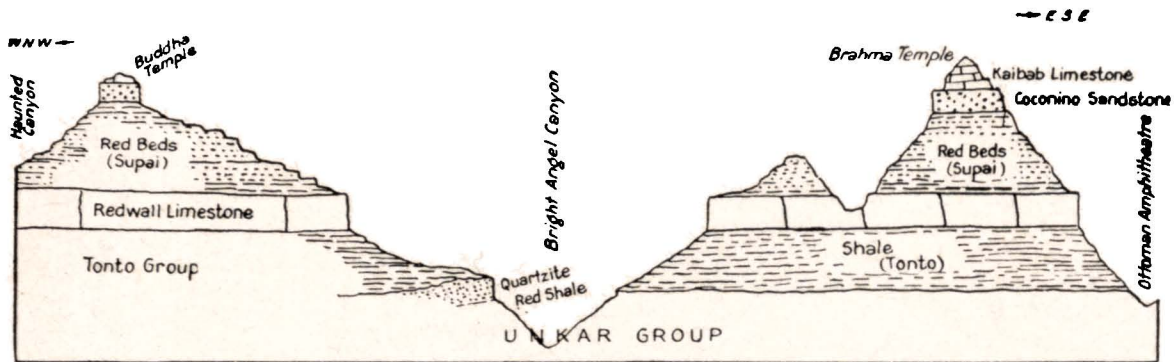


FIGURE 3

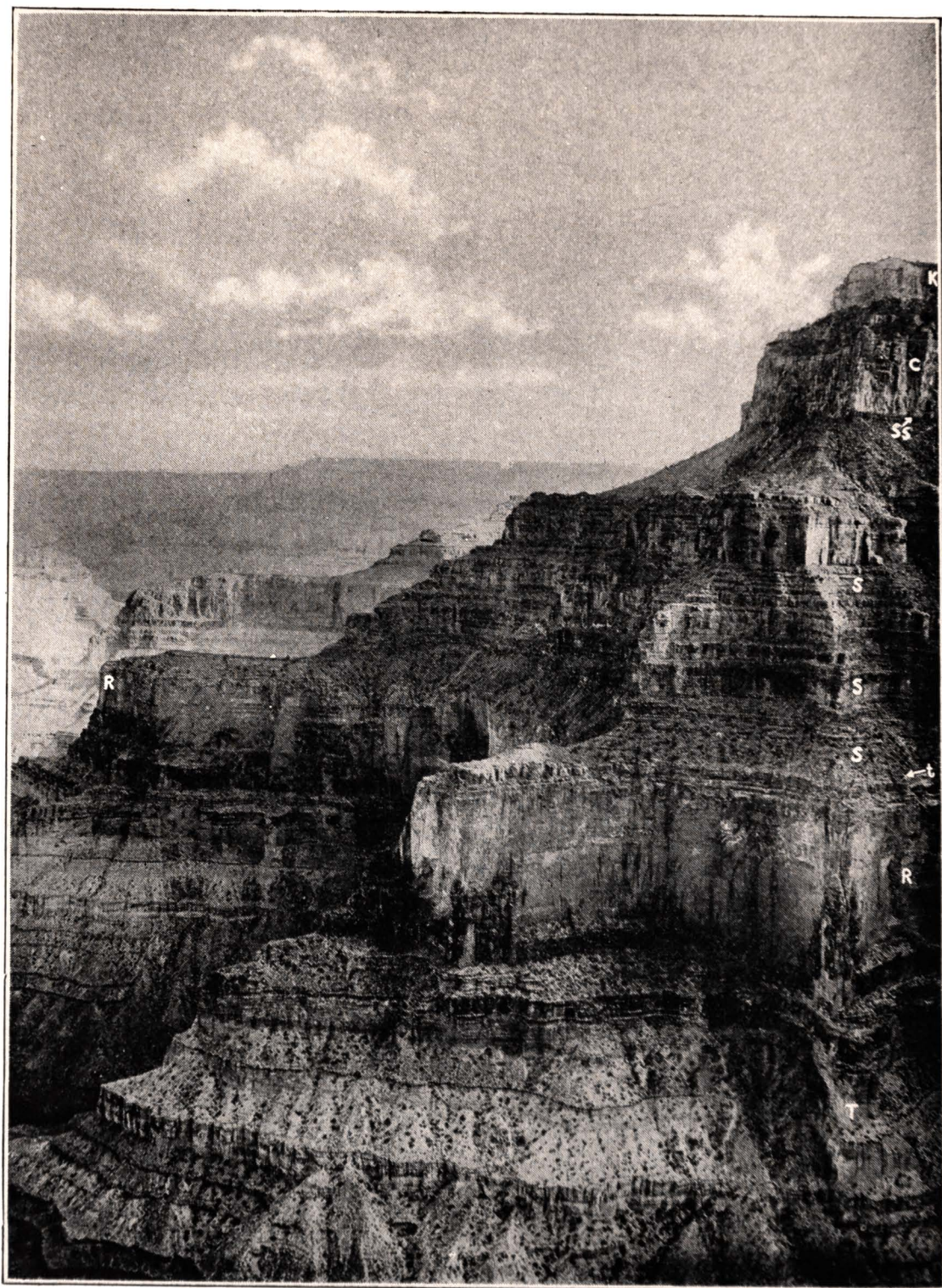
Section Across Bright Angel Canyon from Buddha Temple to Brahma Temple

its junction with the Colorado River. From the rim one cannot see the mouth of Bright Angel Creek, but glimpses may be obtained of its dashing waters at various points higher up. It flows over a rocky bottom of steep declivity and carries a large volume of clear water into the muddy river.

A short distance above the mouth of Bright Angel Creek Canyon the Colorado is spanned by a suspension bridge, erected by the National Park Service, suitable for saddle and pack animals and pedestrians. It is called the Kaibab Suspension Bridge and leads to a trail up Bright Angel Creek.

On the ridges adjoining the Bright Angel Canyon there are numerous pinnacles, towers and mesas in great variety and wonderful forms. On the right hand side Brahma Temple is a prominent feature of





THE GREAT CLIFFS OF THE SOUTH RIM OF GRAND CANYON,  
EAST OF EL TOVAR. LOOKING EAST

K—Kaibab Limestone a top of plateau; C—Co conino Sandstone lying on Red Shale of Supai formation at SS; S—Supai Formation to top of Redwall at t; R—Redwall Limestone (500 Foot Cliff); T—Shales, etc., of Tonto Group.



this character capped by an irregular mass of the Kaibab limestone, 400 feet thick, as shown in figure. Smaller remnants of this enduring limestone constitute the conical top of Zoroaster Temple, south of Brahma Temple, and the flat summit of Deva Temple farther north. Buddha Temple, a pinnacle west of Bright Angel Canyon, is also due to a thin mass of the basal beds of this limestone, lying on an outlying remnant of the Coconino sandstone, while Manu Temple farther north, and Isis Temple west of Phantom Creek, consist of small outliers of the Coconino sandstone alone. From both of these the protecting cap of Kaibab limestone has long since disappeared, having suffered the fate of removal by the elements which will eventually remove the underlying sandstone. In Shiva Temple a large tabular mass of the Kaibab limestone remains separated from the parent plateau to the north by a narrow ridge cut deeply into the red rocks of the Supai formation.

The uniformity of materials in each rock layer in all of these features is evidence of their past continuity across the area now occupied by the canyon and its branches. The great river, and action of rain, wind and streams, has removed the former connecting ledges in the great trench and its branches. The fact that the hard ledges of Kaibab limestone and lower beds succumb in some places and not in others immediately adjacent, is due to a combination of circumstances—a preponderance of erosion or of solution along drainage lines determined in large part before the cutting was far advanced. Separate streams at work on opposite sides of a butte may pare it to a knife edge as the adjoining valleys are deepened and undermining progresses, so that buttresses which are wide at the base taper up into ridges broken by narrow saddles separating pinnacles and peaks of many forms, at various heights. The crest of the ridge out near the gorge usually is Redwall limestone, while farther back, and higher, the ridge consists of red Supai layers, in places capped by remnants of Coconino sandstone. On some of the latter more or less of the Kaibab limestone remains. Farther back the ridge merges into the great Kaibab cliff, rising to the top of the plateau.

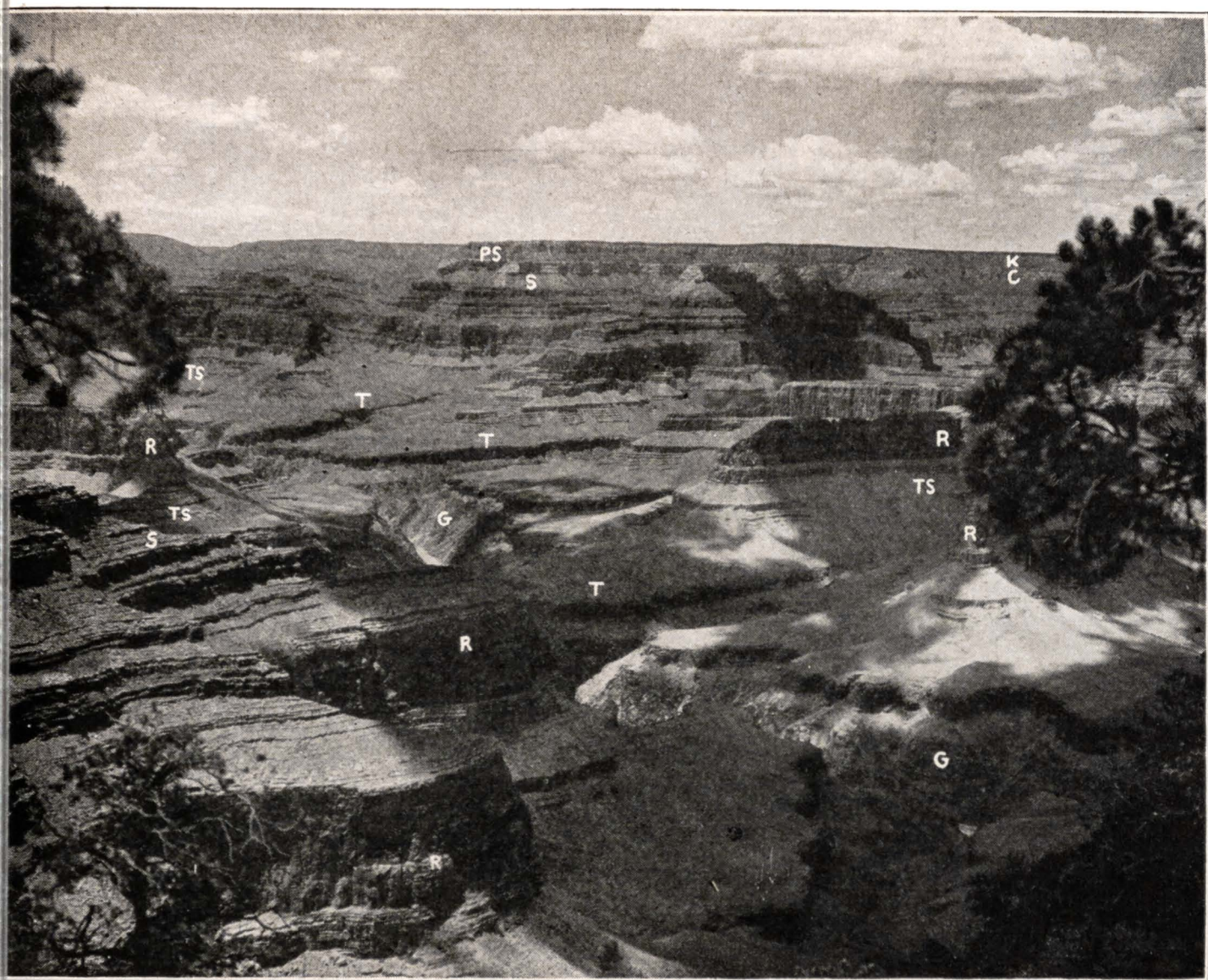


Behind the ridges and temples which rise so majestically from this labyrinth of form, there are many deep canyons, and it is the excavation of these that has controlled the development of the features in the adjoining ridges. Few observers will realize that behind Cheops Temple and the Ridge which projects to the southeast from it, is a very deep canyon, that of Phantom Creek, with granite walls rising over a thousand feet in height. These walls are surmounted on the north side by the sandstone of the Tonto shelf and on the south side by the red shale and quartzite of the Unkar group. In places this canyon is only a couple of yards wide at the bottom; it is occupied by a vigorous stream of cool clear water which augments Bright Angel Creek two miles above the mouth of the latter stream.



THE FIREPLACE, HERMIT'S REST





LOOKING NORTHWEST FROM SOUTH RIM OF GRAND CANYON NEAR PIMA POINT, HAVASUPAI POINT AND POWELL PLATEAU DOWN RIVER TO LEFT

PS—Point Sublime, K—Kaibab Plateau and its Limestone, C—Coconino Sandstone, S—Red Beds of Supai Formation, R—Redwall Limestone, TS—Shale Slope of Tonto, T—Tonto Shelf of Sandstone, G—Granite in the Granite Gorge.



## FROM HOPI POINT

One of the principal places from which to obtain an extended view of the Grand Canyon is Hopi Point, the northernmost projection of the three-pointed promontory about two miles northwest of El Tovar. It is reached by the main Hermit Rim Road which follows the edge of the canyon most of the way to the head of Hermit Trail.

The view is very extensive, showing many features down the canyon for a distance of twenty miles and up the canyon to the western edge of the great plateau which extends east as the "Painted Desert." Portions of the river are visible at a level 4,600 feet below the point of observation, and one can see various northern tributaries—Trinity Creek from the left just below, and minor streams between that creek and Bright Angel Creek. The opposite rim of the canyon eight miles north, is the southern edge of the Kaibab Plateau, ending in many irregular peaks and promontories and deeply recessed on the east by the long straight canyon of Bright Angel Creek.

Shiva Temple, an isolated outlier of the Kaibab Plateau, is a striking feature due north of Hopi Point, as shown in Figure 4. Its broad level top is of Kaibab limestone which constitutes the surface of the main forested plateaus on either side of the canyon. This limestone everywhere surmounts the conspicuous wall of Coconino sandstone which is easily recognized as a band of light-gray color all along the higher walls of the canyon. Descending from the foot of the great cliff of this sandstone are long irregular slopes interrupted by numerous cliffs or high steps; these are of the red shales and sandstone of the Supai formation. It is easily recognized by its bright red color and position in the middle slopes of the mesas and buttresses. Much of the terraced carving in the canyon is in this formation. These red slopes of Supai rocks terminate at the top of the cliff of the Red-wall limestone with its sheer drop of 500 feet to long greenish slopes of shales of the Tonto group.

Extending far out from the middle slopes of the huge terraced mass culminating in Shiva Temple, are long



southward-projecting ridges of the Redwall limestone capped by the red sandstones and shales of the Supai formation. On one of these ridges there remains a small mass of the overlying gray Coconino sandstone; this constitutes Osiris Temple, a prominent pinnacle about  $5\frac{1}{2}$  miles northwest of Hopi Point. A short distance southwest of this temple the beautiful terraces of red ledges of the Supai formation culminate in the Tower of Ra, a mass of brilliant red sandstone. A great southerly projection of the ridge on which Osiris Temple rises has two culminating peaks known as Horus Temple and the Tower of Set, made of red rocks of the Supai formation.

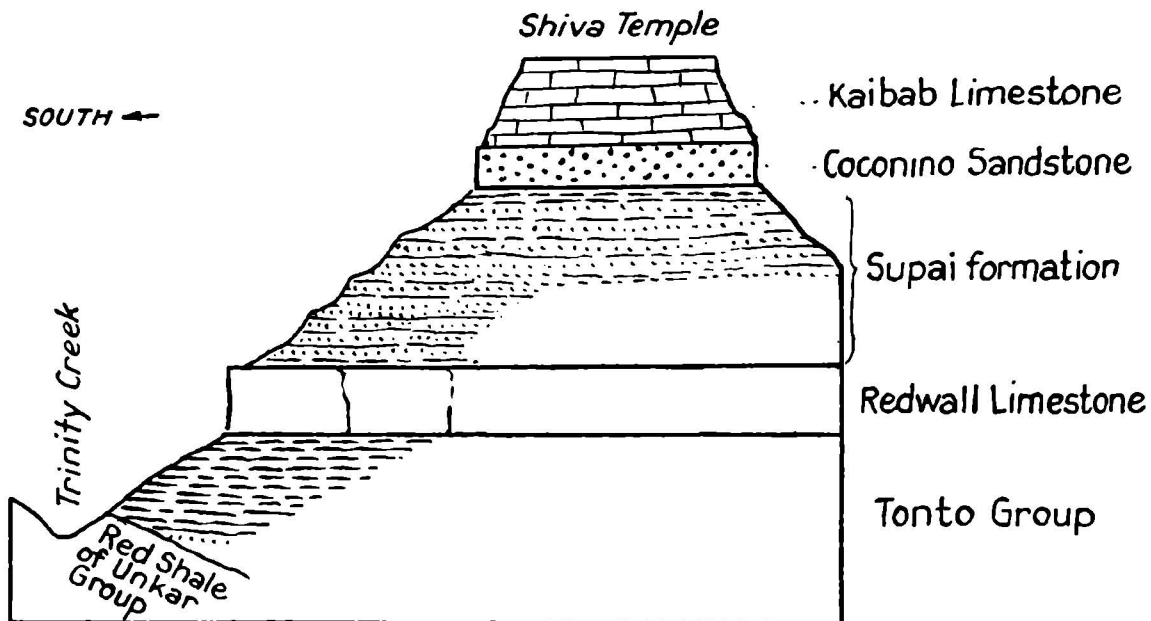
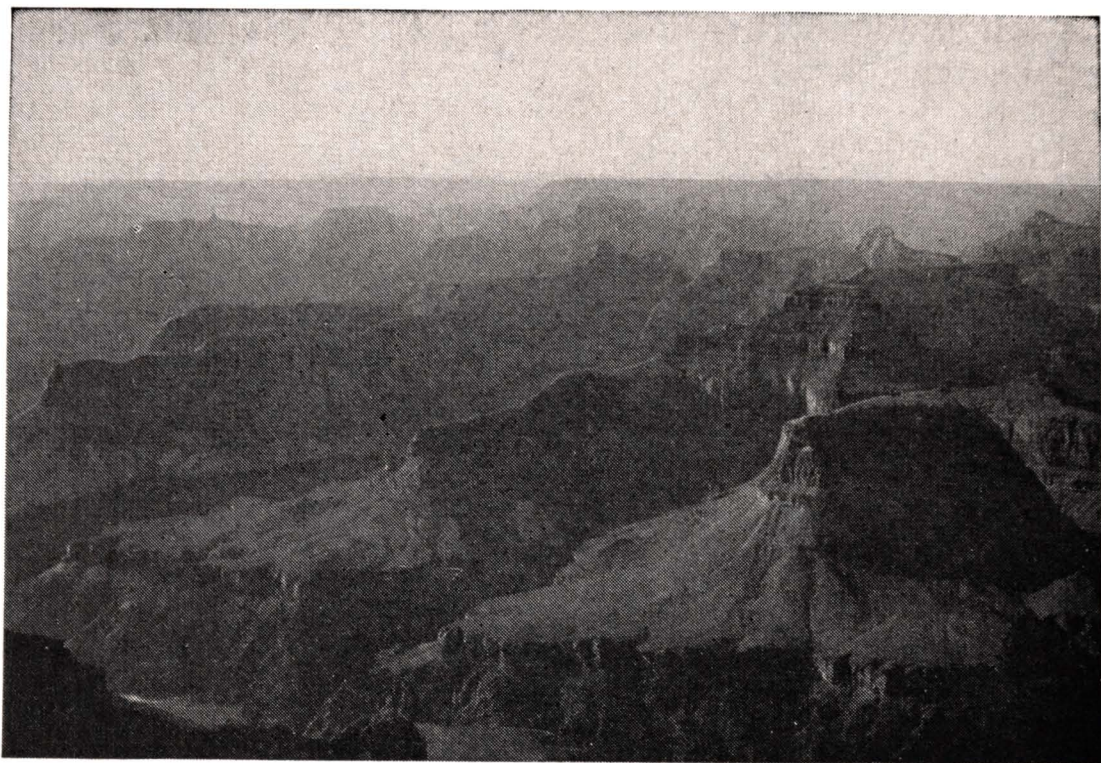


FIGURE 4  
Section Through Shiva Temple

The high ridge southeast of the Shiva Temple mass consists of Redwall limestone capped by a thick succession of the red Supai rocks. It is tipped by a small remnant of the Coconino sandstone, constituting the striking feature known as Isis Temple. Not long ago geologically, this temple, as well as the closely similar Osiris Temple, was capped by Kaibab limestone as in Buddha, Shiva, and several other of the higher edifices; this has been removed by the elements. Now, having lost the protecting cap of Kaibab limestone, the softer sandstone is being rapidly removed by erosive agencies.

Buddha Temple rises in a beautiful pyramidal mass of Kaibab limestone on the next ridge east of Isis Temple





A GRAND CANYON SUNSET—HOPI POINT

(see Figure 3); Manu Temple with its small cap of Coconino sandstone, is a mile farther back and slightly to the right of Buddha Temple. On a southward prolongation of the same ridge as Isis Temple but at a much lower level, is Cheops Pyramid, a remarkable flat-topped remnant of the Redwall limestone, separated by erosion from the ledges of that limestone to the north and west. Its vertical walls, 500 feet high, descend to the long slopes of the green shales of the Tonto group. Farther down these slopes are dark quartzites, red shales and sandstones of the Unkar group which constitute a large part of the lower middle slopes of the area between Trinity and Phantom creeks. These rocks are remnants of a very old formation lying between the granite and the Tonto beds in various parts of the canyon. The beds of the Unkar group slope steeply to the north in striking contrast to the nearly horizontal bedding of the overlying formations.

Throughout this region the river gorge is cut in granite which rises in steep dark walls a thousand feet high to the platform caused by the sandstone at the base





POINT SUBLIME

of the Tonto group. The gorge swings close to the foot of Hopi Point and to the left the rushing, turbulent waters of the Colorado can be seen. The river here is about 250 feet wide, though from this height it appears a narrow stream.

Looking northwestward from Hopi Point, or down the Grand Canyon, one sees on the left the northern edge of the forested Coconino Plateau with its many projecting points, as far west as Havasupai Point. Between these points numerous deep canyons are recessed, but they are very short as compared with the long valleys on the north side of the canyon, several of which can be seen in their entirety from Hopi Point. The highest distant ridge which limits the view to the northwestward is Powell Plateau, which lies beyond the great basin (called Shinumo Amphitheatre) cut far back into the Kaibab Plateau by Shinumo Creek. Point Sublime is a



## 34 STORY OF THE GRAND CANYON OF ARIZONA

far south-reaching projection of the Kaibab Plateau on the east side of Shinumo basin. It is made up of the beds shown in Figure 5.

On the east side of Shinumo Amphitheatre, Sagittarius Ridge projects far south into the main canyon. It is recognizable by the diminutive but conspicuous red knob which surmounts its southern extension, Scorpion Ridge. This small knob is a remnant of one of the hard red beds in the upper part of the Supai formation, a great mass of which constitutes the upper part of the ridge.

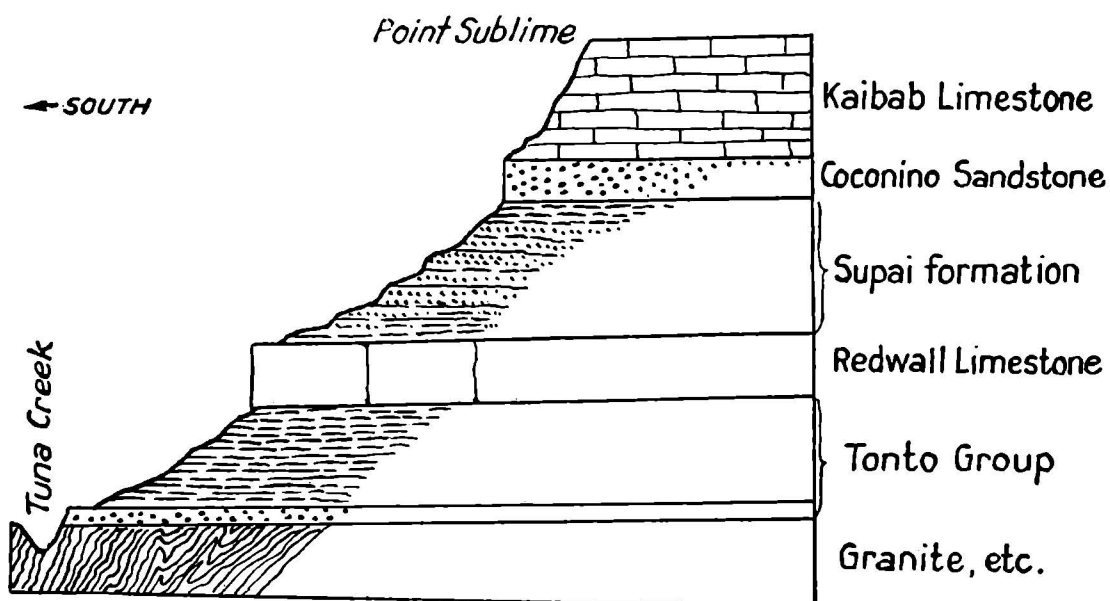


FIGURE 5  
Section Through Point Sublime

On the south side of the river lies Diana's Temple. It appears to be a promontory of the southern plateau, but erosion has cut it off by a depression which can be seen on close scrutiny. It still retains its covering of Kaibab limestone surmounting a great cliff of gray Coconino sandstone and from its foot is a long projecting ridge of red Supai beds, extending north to Marsh Butte, a tabular promontory of Redwall limestone. A short distance north of this butte, the river in its granite gorge is seen bending to the west preparatory to its northern sweep around the south end of Scorpion Ridge.

Looking northeastward from Hopi Point there is a superb view up the canyon of Bright Angel Creek with its wonderful panorama of temples rising at intervals on



the great projecting ridges on either side. This canyon is cut far back into the Kaibab Plateau, projections of which extend in an irregular line of deeply notched cliffs on either side. The relations of the rocks are shown in Figure 3. As in all the other sections, there is at the top the great cap of Kaibab limestone presenting the irregular light-colored cliffs so characteristic of that formation. Next below is a band of gray due to the high vertical wall marking the out-crop of the Coconino sandstone which may easily be traced all along the wall. It descends to the great irregular slopes and steps of the bright red sandstones and shales of the Supai formation more than

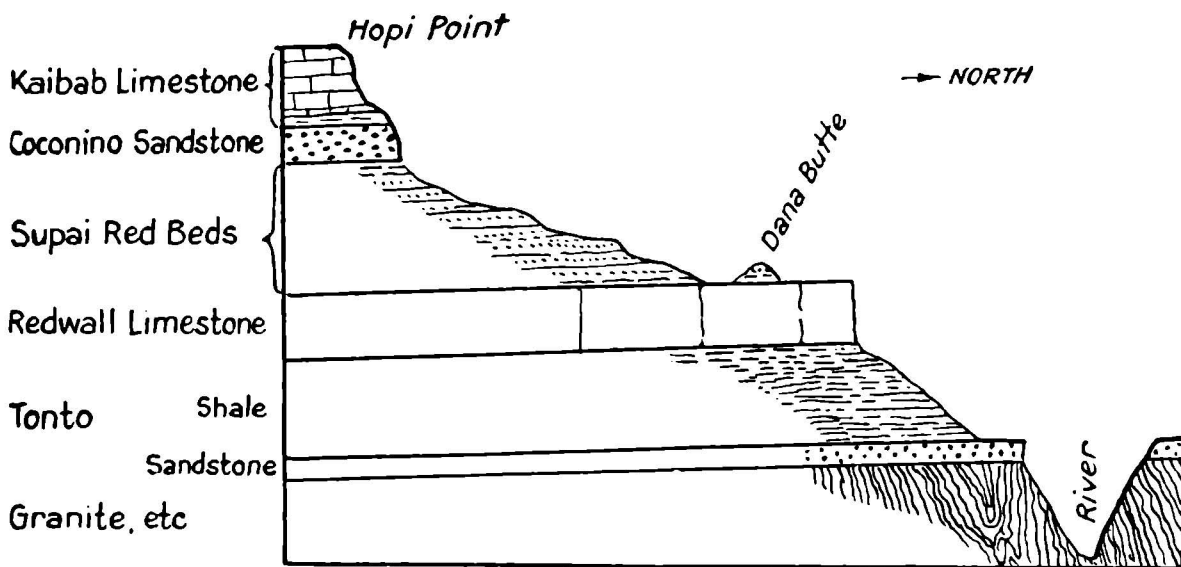


FIGURE 6  
Section From Hopi Point to Colorado River

1,100 feet thick constituting the large part of the ridges which project so far south in the northern slope of the canyon.

It is outlying masses of the upper formation remaining at intervals on these ridges which produce the striking peaks such as the Temple of Buddha, pinnacled Zoroaster, angular Brahma, and the less conspicuous Deva and Manu temples. All of these pinnacles retain the cap of Kaibab limestone, except the last, which is an outlier of the Coconino sandstone from which the overlying limestone has been removed by erosion.

The long projecting spurs of Redwall limestone with its characteristic 500-foot cliff are prominent features in the landscape. Above is the great series of red slopes



and step-like terraces of the Supai beds. Below is the long slope of shale extending to the shelf of the sandstone at the base of the Tonto group. These features may be readily recognized throughout the lower middle slopes of the main canyon and far up the canyon of the Bright Angel and other creeks. In the ridge west of the mouth of Bright Angel Creek, and in the middle portion of Bright Angel Canyon the Tonto shelf is interrupted by precipices of the hard quartzites and limestones with slopes of intervening red shale constituting the Unkar group. In the very remote times when the basal Tonto was laid down, these Unkar rocks were an island around which the earlier Tonto beds were deposited. Later in Tonto time this island was submerged and finally buried by muds now constituting the shales of the Tonto group.



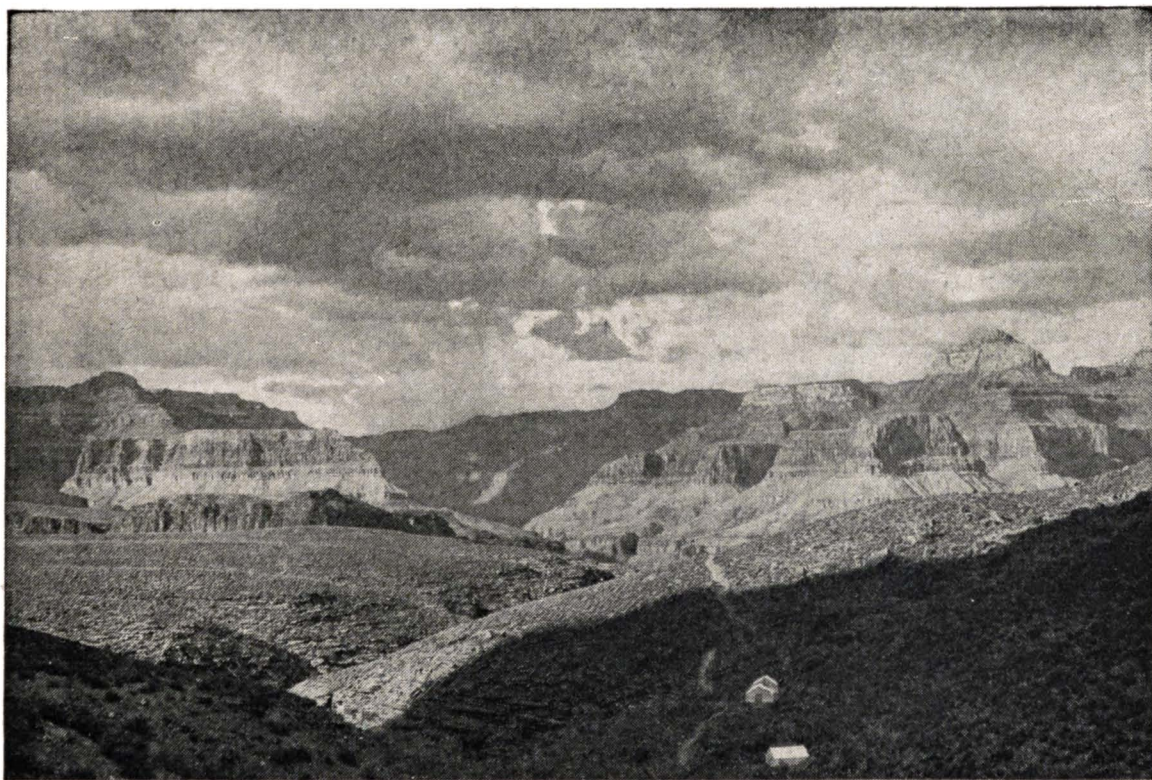
THE NAVAHO AT HOME, GRAND CANYON



Hopi Point also affords an excellent view due east far up the Grand Canyon, although projections from the south wall and some of the ridges of the north side cut off part of the view. The granite gorge is plainly visible to its eastern end, where as the granite passes underground, its gorge gives place to a wide, irregular valley with many cliffs and high ridges of the steep dipping beds of the Unkar group. The Tonto Platform is conspicuous in places with long shale slopes above rising to the foot of the high cliff of Redwall limestone.

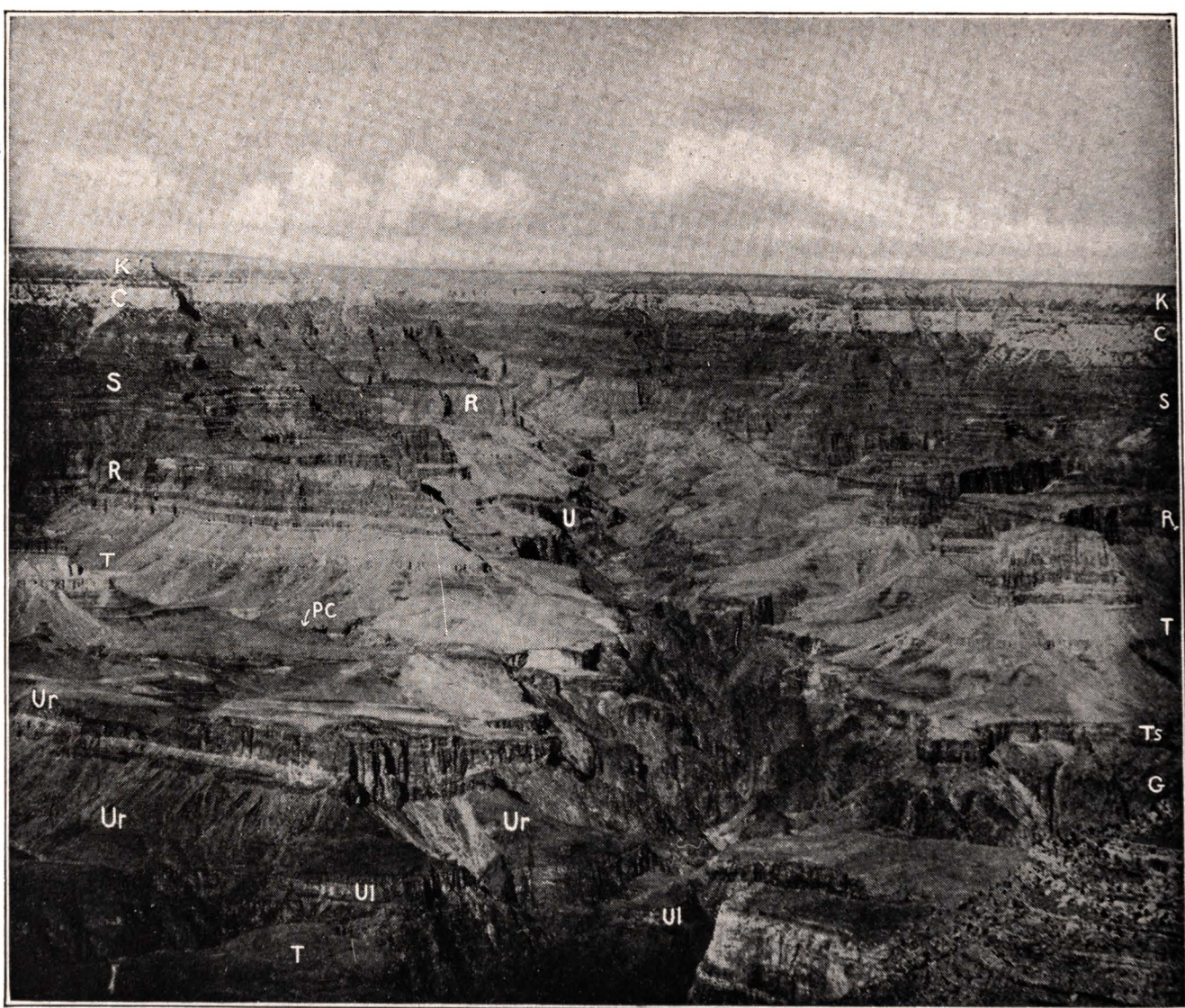
East of Bright Angel Canyon the Kaibab Plateau projects far to the south, ending in the great precipice of Cape Royal, but represented also by the high flat-topped outlier known as Wotan's Throne. A distinctive cupola of Kaibab limestone renders the huge pile of Vishnu Temple a familiar feature from all viewpoints.

Far in the distance the east wall of the canyon is distinctly visible almost as far north as the mouth of the Little Colorado River. It is the west face of a plateau which extends many miles to the east and in clear weather there may be seen at still higher levels, the long ridges beyond the Painted Desert, on which the Hopi Indians have built their villages.



TONTO TRAIL FROM THE INDIAN GARDENS





# LOOKING UP BRIGHT ANGEL CANYON FROM YAVAPAI POINT

Kaibab Plateau with its Limestone (K) in Distance. C—Coconino Sandstone, S—Red Beds of Supai Formation, R—Redwall Limestone, T—Tonto Shelf, TS—Tonto Shelf (Sandstone), U—Dark Quartzite of Unkar Group, Ur—Red Shale of Unkar Group, UI—Limestone of Unkar Group, PC—1,200-Foot Canyon of Phantom Creek.



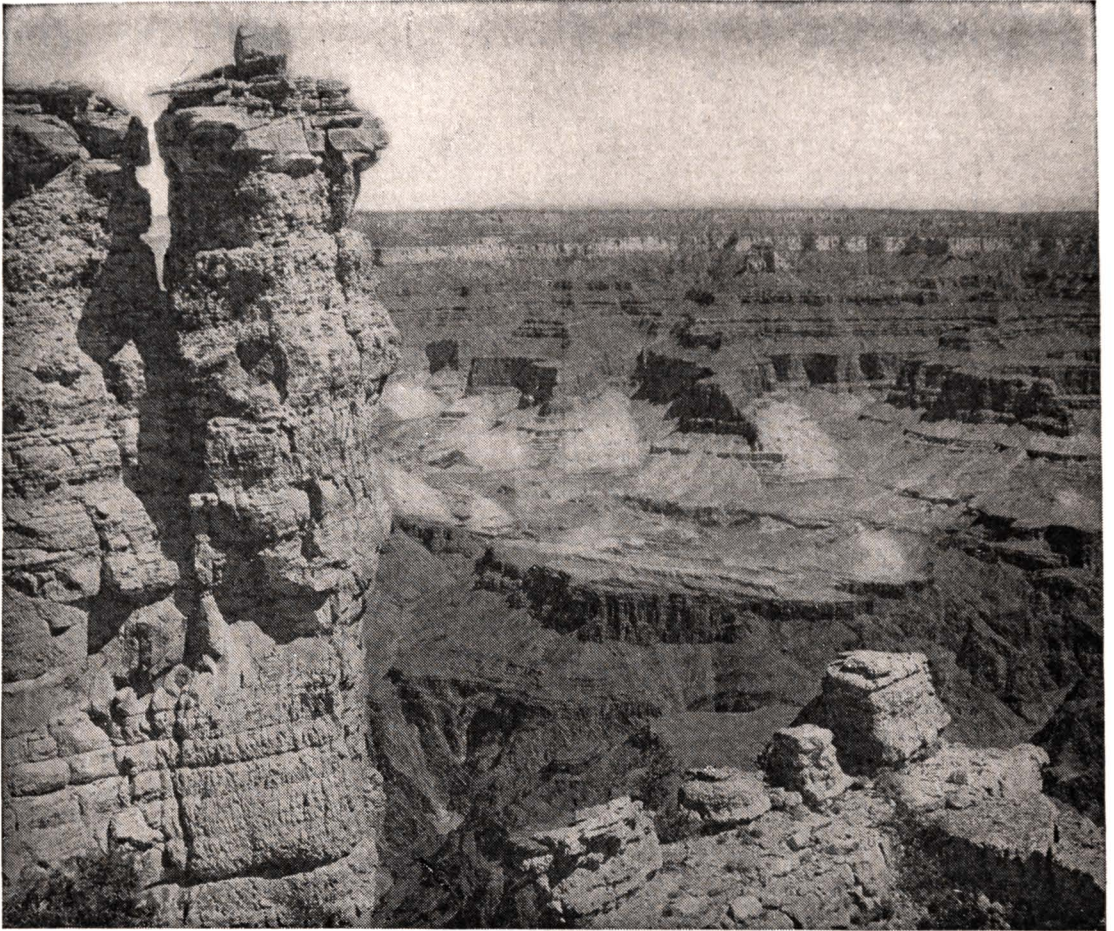
## YAVAPAI POINT

Yavapai Point, altitude 7,050 feet, is the projection of the Coconino Plateau a mile and a half northeast of El Tovar. The view is similar to that from Hopi Point, although possibly slightly less extensive, with some very interesting differences in details. It affords an exceptionally good vista up Bright Angel Canyon to its head, and a very advantageous sight of the vast array of ridges, buttresses and temples to the north, northwest and northeast, extending for many miles along the north side of the Grand Canyon. At one's feet are great cliffs and steep slopes descending 4,500 feet into the canyon of Pipe Creek, the water of which empties into the river about 3 miles north of Yavapai Point. It is down Pipe Creek that Bright Angel Trail leads from the Platform to the river.

To the east from Yavapai is Yaki Point  $1\frac{1}{2}$  miles away, presenting the full succession of beds down to the granite. Toward its base are bold cliffs of Redwall limestone, rising to a long promontory of red beds of the Supai formation which culminate in a peak known as O'Neill Butte. Beyond O'Neill Butte can be seen Newton Butte with its flat top of red sandstone of the Supai formation and another Supai outlier further down its extension toward the river. Newton Butte lies below Shoshone Point, another promontory on the Coconino Plateau. The great summit wall in the distance to the east is at the western edge of the Painted Desert through which the Little Colorado has cut its canyon.

Looking north across the Grand Canyon probably the most conspicuous feature is Buddha Temple, capped by the hard basal bed of the Kaibab limestone. Manu Temple, behind it to the right, and Isis Temple, in front of it to the left, have lost this resistant layer and the Coconino sandstone is rounding away beneath the effects of rain and other erosive agents. Zoroaster, Brahma, and Deva Temples, the great structures that flank Bright Angel Creek on the east, still retain a capping of this resistant limestone. In Cheops Pyramid the Coconino and Supai beds also have been removed and this tabular





THE VIEW FROM YAVAPAI POINT

mass of the Redwall limestone has been separated from the main ledges of the formation by erosion.

Looking northeast there is a myriad of gigantic sculptured masses. Wotan's Throne dominates. It is the central feature of a great ridge extending south from Walhalla Plateau at Cape Royal, with an intricate series of branching ridges exhibiting a marvelous assemblage of notable forms. The rocks of which it consists are shown in Figure 7.

It is capped by an outlying area of the Kaibab limestone, here 700 feet thick, the flat top of which reaches an altitude of 7,700 or nearly 700 feet higher than Yavapai Point. Below the limestone ledges is a great encircling wall of the gray Coconino sandstone, conspicuous as an almost continuous precipice 300 feet in height. Below this are the usual long slopes of red shales interrupted by frequent terrace-form cliffs of the harder red sandstones of the Supai formation. On a great ridge projecting to the southwestward, three small masses of the Coconino



sandstone have been spared from erosion. Two of them, standing close together, are called Angel's Gate. This feature is difficult to discern in some lights, but it may be seen by looking directly over the summit of O'Neill Butte toward Wotan's Throne. The large ridge east of Wotan's Throne culminates in the very prominent cupola of Vishnu Temple. This has for its cap a small but thick remnant of the Kaibab limestone that has been removed

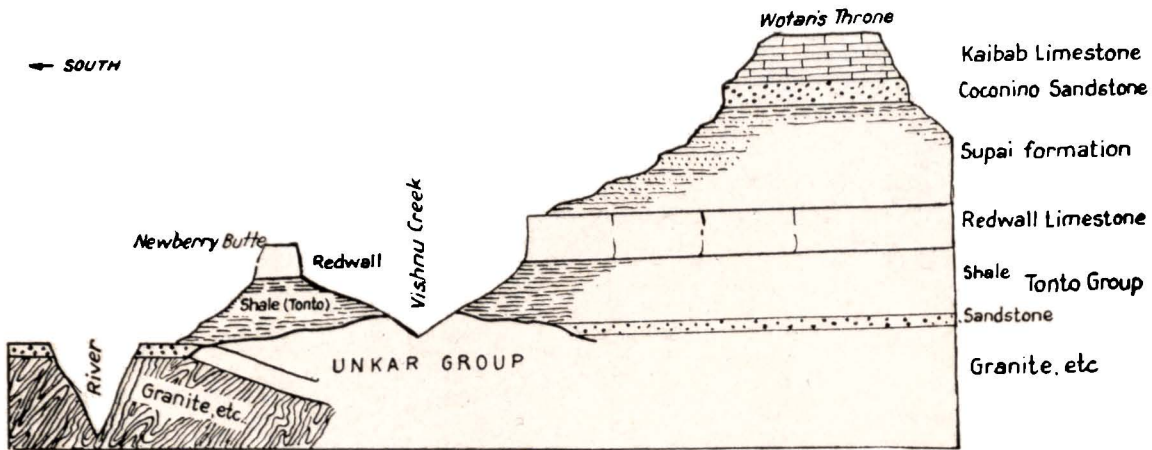


FIGURE 7  
Section North Through Wotan's Throne to Colorado River

by erosion in the surrounding area. Under this limestone cupola there is a large mass of Coconino sandstone. Krishna Shrine and Rama Shrine, peaks of the two ridges branching southward from Vishnu Temple, consist of red sandstone and red shales of the Supai formation. Farther down is the prominent and characteristic cliff, 500 feet high, of the Redwall limestone and outliers of this bed constituting the tabular masses of Newberry Butte, Sheba Temple and Solomon Temple. These latter features lie so low and are so distant from Yavapai Point that they cannot be seen to advantage from that place. Everywhere below the steep, straight wall of Redwall limestone is the greenish slope of the shales of the Tonto group.

The relation of the sandstone at base of the Tonto group to the underlying Unkar group is well exhibited from this point of view. As has been stated in "The History of the Rocks," the Unkar and Chuar group of rocks, originally many thousand feet thick, were extensively removed by erosion before the deposition of the Tonto for-



mation. A great wedge-shaped mass of the Unkar group is well exposed to the north across the river from Yavapai Point. It appears below the slopes of green Tonto shale in front of Cheops Pyramid, and extends eastward for a mile or two. Its basal limestones are succeeded by a thick mass of red shales, easily recognized; these in turn are surmounted by cliffs of dark colored quartzites, all dipping at a moderate angle. This quartzite ridge extends along the middle slopes for some distance northwest, to the foot of the ridge that culminates in Isis Temple.

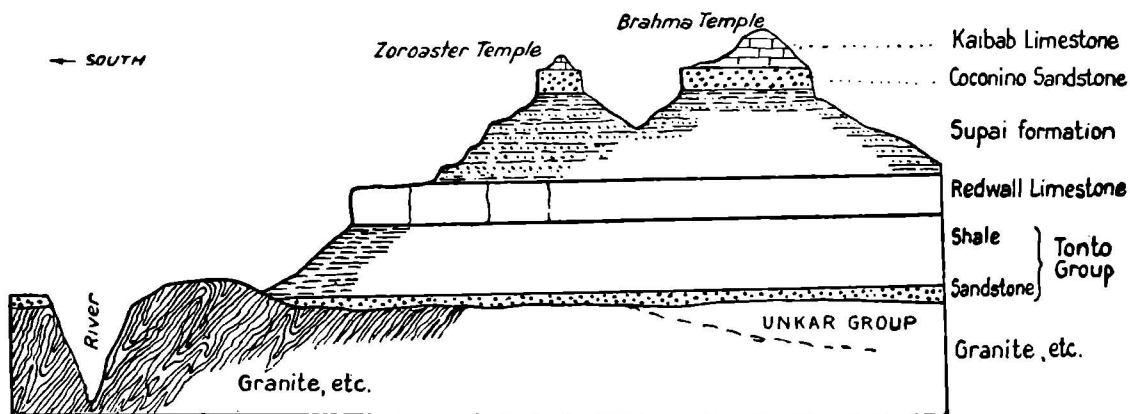


FIGURE 8

Section Through Brahma and Zoroaster Temples to Colorado River

Another thick mass of these Unkar rocks is exposed along the canyon of Bright Angel Creek beginning three miles above the mouth of that stream and extending about four miles to the north. Still other areas will be recognized by the red color of the tilted shales member, in the canyon of Clear Creek or Ottoman Amphitheatre east of Zoroaster Temple, in the slopes on the south side of the granite gorge south of the mouth of Bright Angel Creek, and in several other canyons farther east.

Another interesting detail is visible on the north side of the granite gorge below Zoroaster Temple where a mound of granite rises slightly above the Tonto platform east of Clear Creek, as shown in Figure 8. Evidently this was an old island in the shallow waters which deposited the sand of the sandstone at the base of the Tonto group.

Interesting details can also be seen in the Unkar mass capping the granite south of the river southeast of



the mouth of Bright Angel Creek. Here early earth-crust movements resulted in many faults which broke the beds into numerous blocks as shown in cross sections, Figure 9. One of these faults passes up the valley of

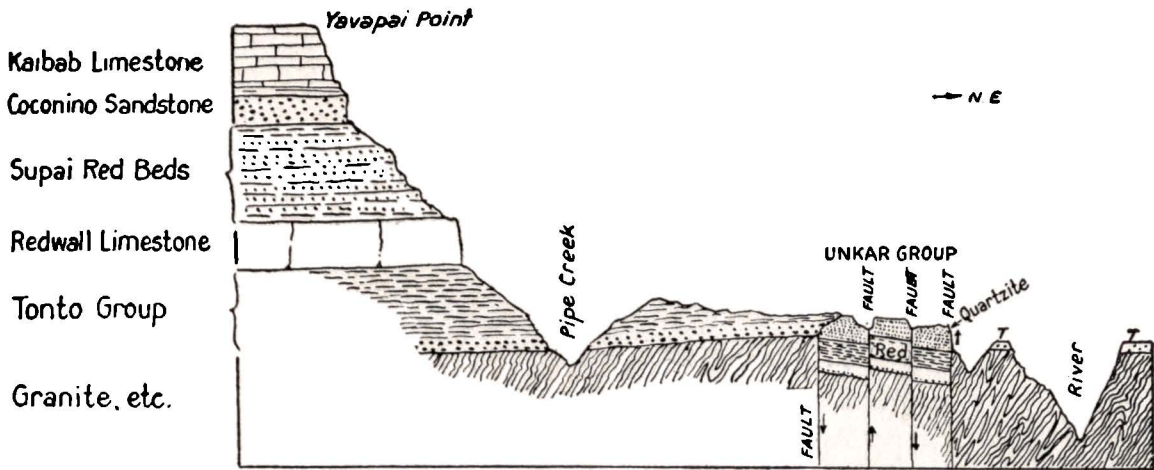
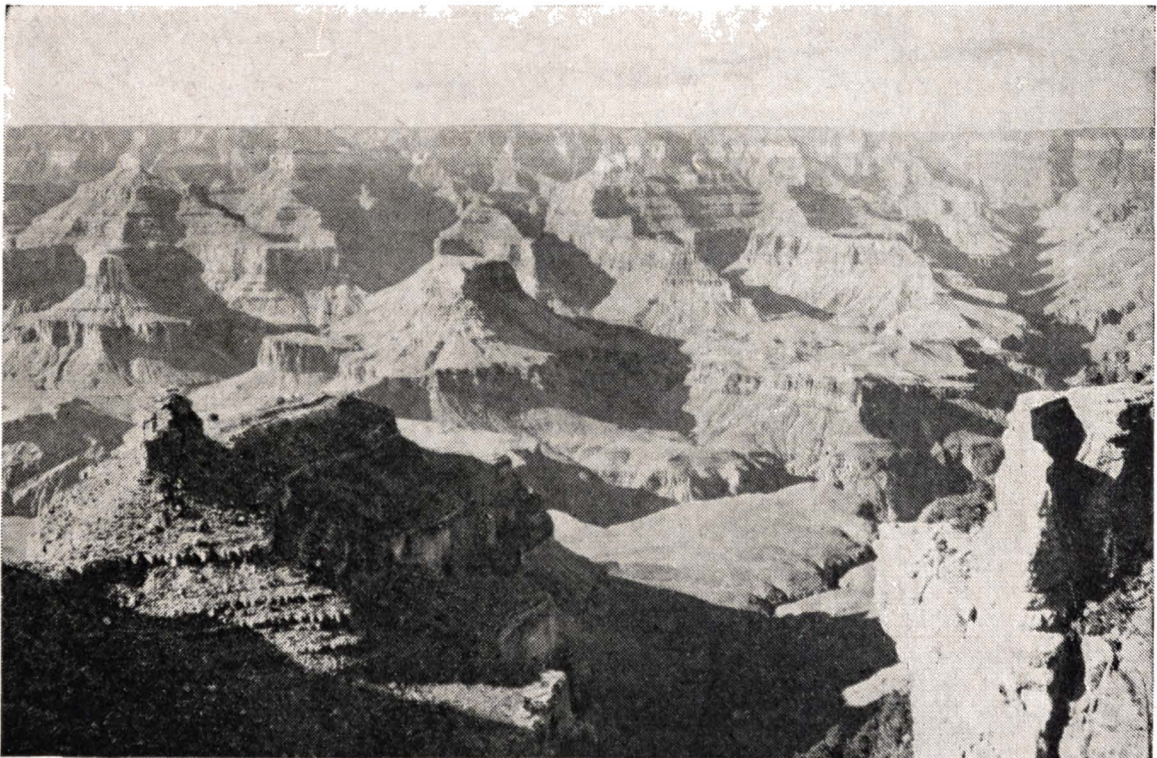


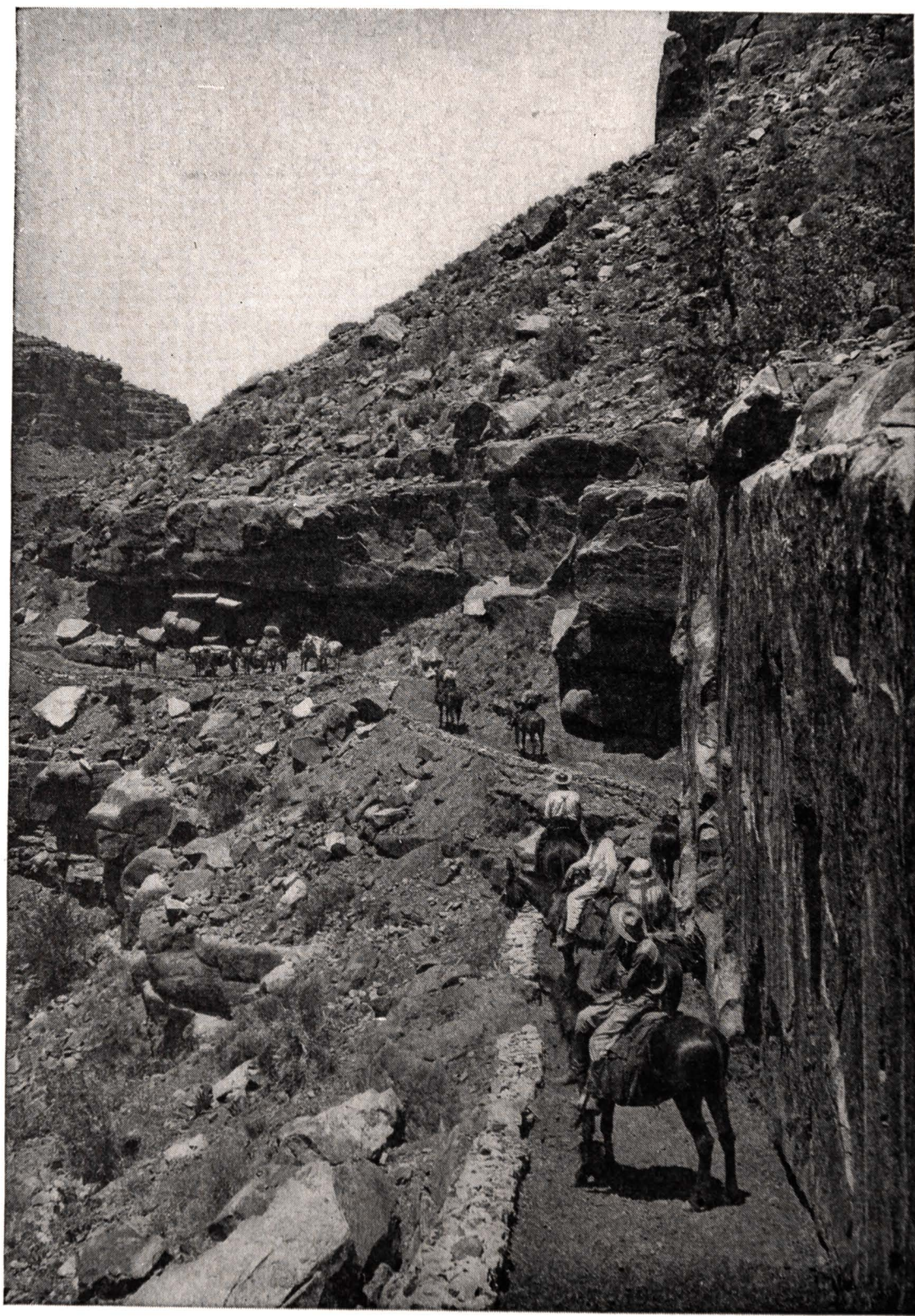
FIGURE 9  
Section From Yavapai Point Northeast to Colorado River

Cremation Creek between O'Neill and Newton Buttes, and finally develops into a sharp bend in the beds. This bend or tilt extends southeastward past Grand View, Three Castles, and far southeastward across the Coconino Plateau.



"A THIRTEEN MILE LOOK ACROSS THE CANYON"





ON HERMIT TRAIL



## THE ROCKS AND FAULT IN BRIGHT ANGEL TRAIL

The trail which descends into the canyon a few rods west of El Tovar Hotel affords a complete and instructive exposition of the rocks of the canyon walls. Most of the features are so clear that anyone can recognize them. The section in Figure 10 shows the general succession of rocks.

At the top and in many cliffs down the first few zig-zags is the Kaibab limestone, a white, fine-grained rock in beds which separate into layers every few feet. Impressions of fossil shells are abundant in some layers and many fragments of hard yellowish flint will be noted. This limestone series is about 700 feet thick in the canyon walls.

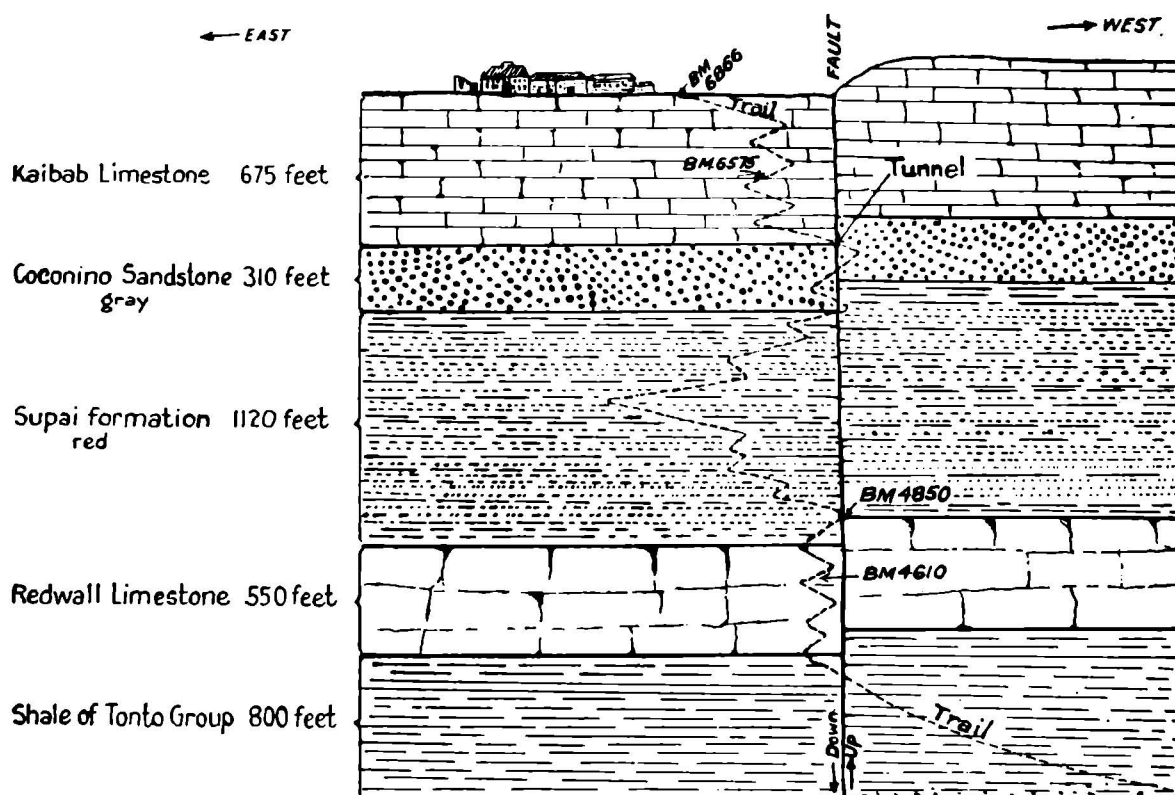


FIGURE 10

Diagram of rocks on Bright Angel Trail from the summit to Indian Gardens. Looking south. Shows relations of fault or break in the beds. Trail generalized. The B. M. are metal bench marks of the U. S. Geological Survey showing heights above sea level.



At the east entrance to the little tunnel through which the trail passes some exceptionally interesting features are exposed. Here the base of the Kaibab limestone is seen lying on the Coconino sandstone. The top of the latter forms a shelf at the summit of a high cliff which the trail just reaches at the mouth of this tunnel. The change from one formation to another is abrupt, but there are a few inches of passage beds so that the precise plane of contact is difficult to recognize. The following diagram shows some of the features:

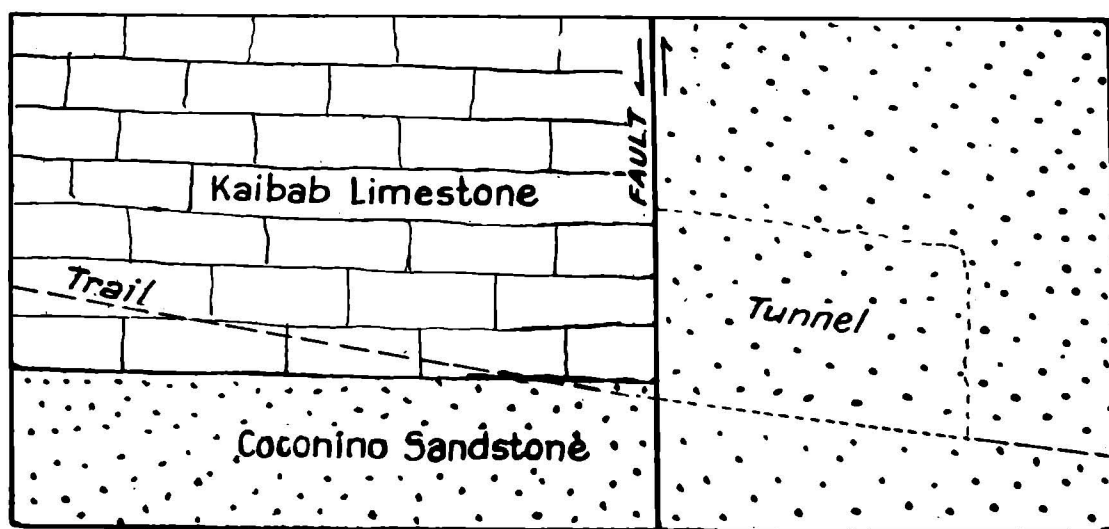


FIGURE 11

Diagram of fault crossing Bright Angel Trail at the Tunnel. Looking south.

At the tunnel the trail reaches a fault or vertical break by which the rocks to the west were uplifted bodily about 140 feet by an upheaval of the earth's crust. The fault or plane of movement extends up the face of the cliff at the east entrance to the tunnel and consequently the tunnel is entirely in the uplifted Coconino sandstone. The plane is distinctly shown by the discontinuity in the rock beds, but instead of an open joint the break is filled with calcium carbonate constituting a vein about a foot wide.

From a point up the trail a short distance back from the tunnel a glance west across the fault shows that as a result of the uplift, the basal beds of the Kaibab limestone are much higher on the west side than on the east. The uplifted Coconino sandstone on the west side of



the fault presents a great cliff which is very conspicuous beyond the tunnel. It is this fault and the loose material from it that has made a trail practicable here, for nearly throughout its course along the canyon walls the 300-foot cliff of Coconino sandstone is an impassable barrier.

At the foot of this cliff there may be seen the sharply marked contact of the coarse Coconino sandstone with the bright red shale at the top of the Supai formation. This contact is particularly well-exposed near the trail on the west side of the fault and it may be seen also at intervals along the cliffs at other places. A few feet below this basal contact on the east side of the fault there is the U. S. Geological Survey bench mark reading 5866. The trail makes many zigzags down the steep slopes and high steps of the red shales and red sandstones of the Supai formation. Their thickness is 1,150 feet. Owing to frequent alternation of hard sandstone layers and soft shale masses, the Supai formation presents a great succession of red terraces all along the middle slopes of the walls on both sides of the trail, notably in the Battleship to the west of the trail, in Dana Butte, still farther west, and in O'Neill Butte some distance east. Another characteristic feature of the Supai formation is its red color which prevails throughout.

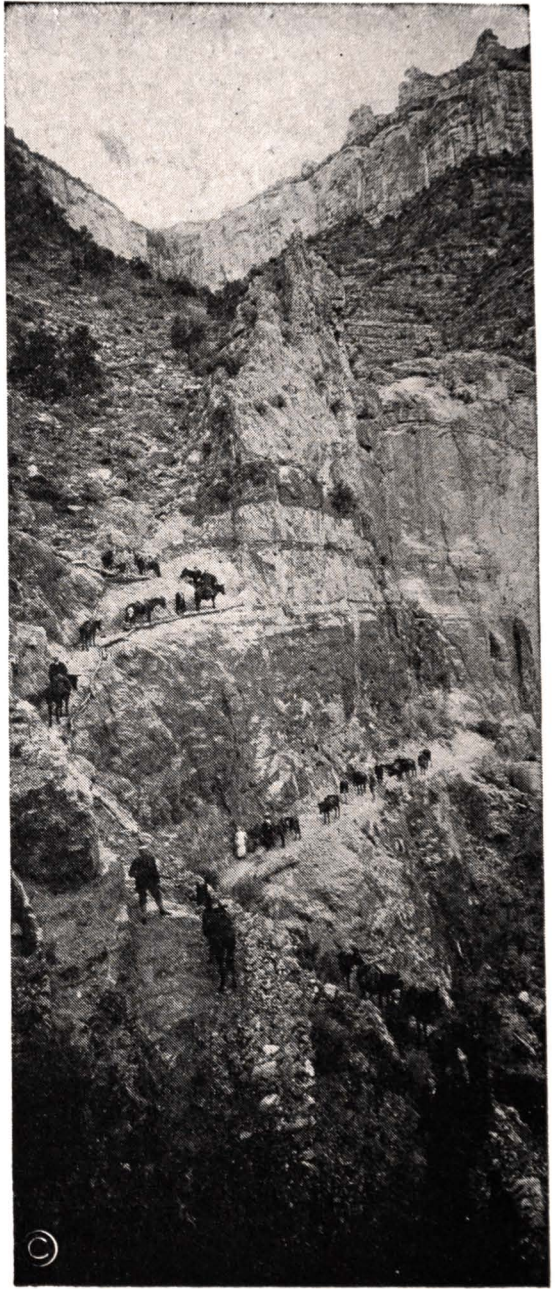
At its base there is rapid change of sediments to the great massive ledge of Redwall limestone which everywhere presents a typical 500-foot cliff about half way down the canyon walls. This limestone cliff is stained red to a greater or less extent by wash from the red shales above, but when the rock is broken into it is seen to be of light gray color. The first ledges of Redwall limestone are about 2,000 feet below the rim of the canyon, and bench mark 4850 is on the surface of the first prominent ledge.

In the Redwall limestone the trail winds down irregular slopes east of the fault and then passes through extensive rock cuts necessary to pass the principal cliffs which otherwise would be quite impassable for the horses. A few rods west of the trail there will be noted one of the great cave-like alcoves in the Redwall cliff which are typical of the rock. After descending the Redwall Cliff and some minor steep slopes, marking the hard



upper beds of the Tonto group the trail passes down the long slope of the shale of the Tonto group and the valley excavated in it, to the Indian Gardens. Here some small but vigorous springs emerge, probably rising through crevices from the upper part of the sandstone of the Tonto group, which is at no great distance below the surface. The water of these springs has been utilized for limited irrigation for a long time, as the Indians raised crops here many centuries before the white man penetrated the canyon.

A short distance beyond Indian Gardens the trail passes out of the little valley of Garden Creek onto the Tonto Platform, an extensive shelf due to a hard bed of sandstone—a feature which is characteristic throughout the Canyon. Here the trail divides, one branch going north to the north edge of the Tonto Platform or “plateau,” and the other winding to the northeast to descend into the valley of Pipe Creek which gives access to the bottom of the granite gorge. From the edge of the Tonto Platform a very fine view is obtained not only of the granite gorge below, which is here 1,380 feet deep, but of many of the great promontories of Redwall limestone and red Supai beds. It is only from the depths of the canyon that one can obtain a proper conception of the scale and true relations of its features, for the sense



JACOB'S LADDER  
BRIGHT ANGEL TRAIL





THE DEVIL'S CORKSCREW  
BRIGHT ANGEL TRAIL

of proportion is very much dwarfed by elevation at the rim.

From the Tonto Platform there is a very comprehensive vista up the canyon of Bright Angel Creek, the lower part of which is in granite and gneiss and the middle part in the red shales and associated rocks of the Unkar group. The character and relations of a great wedge of these Unkar rocks are also plainly visible much nearer by, on the north side of the river where they underlie an area of considerable extent.

Due north of the point of view there is a shelf of the Tonto sandstone corresponding to the one on which the observer stands; behind this toward Cheops Pyramid and Isis Temple are steep

slopes of the red shales of the Unkar group surmounted by the dark gray quartzite near the top of the Unkar group. These rocks extend to the brink of the canyon northeast of the point of view where the basal limestones rise as great dark cliffs surmounting the steep slopes of the granitic rocks of the inner gorge.

Looking eastward one can see some outlying masses of the Unkar rocks on the south side of the river; two of them, only a mile and a half east, are in plain view.



Others faulted into narrow slivers (as shown in section in Figure 9), are two miles farther east but hardly in view from the Tonto Platform.

The river is about 300 feet wide and usually runs about 25 or 35 feet deep. The swift current is always turbid with the sediment it is carrying. This sediment is the sand and silt washed from the valley slopes and the total amount carried in the course of the year, especially in times of flood, is very great. During the short but vigorous rains which occur occasionally about the canyon, every little rivulet is loaded with sediment; this is carried down the steep declivities and poured into the river channel to be finally removed by the great stream in its never-ending flow to the southwest. By this means every little canyon is being deepened and cut farther back so that it is only a question of time, under present conditions, when all the slopes will be cut away and the entire province reduced to a plain so smooth that streams can no longer carry away the products of disintegration.



HERMIT'S REST INTERIOR



## FROM GRAND VIEW POINT

Grand View Point is 11 miles southeast of El Tovar Hotel. It is reached by an excellent road about 15 miles long, the greater part of which passes through attractive forests and glades some distance south of the canyon. The Point is a mile and a half north of the house at Grand View. The outlook from it is regarded by many persons as the finest in the canyon. It presents numerous notable features which cannot be seen from points farther west and therefore the visit to this place is important for those who wish to see some especially fine scenery and gain a more comprehensive knowledge of the canyon.

To the north is a huge promontory of the high forested Kaibab Plateau, called Walhalla Plateau. This is at about the same level as the promontory of the north rim opposite El Tovar. Looking east one sees the Colorado coming from the Marble Canyon to the north, and sweeping around into a southwestward and finally to a westward course, finally entering the deep, narrow granite gorge in the center of the vista. To the west are the various high ridges and peaks that rise between Grand View Point and Bright Angel Creek.

The south wall of the canyon at Grand View Point has a height of 7,406 feet or 235 feet higher than Hopi Point. In this vicinity many long ridges project from

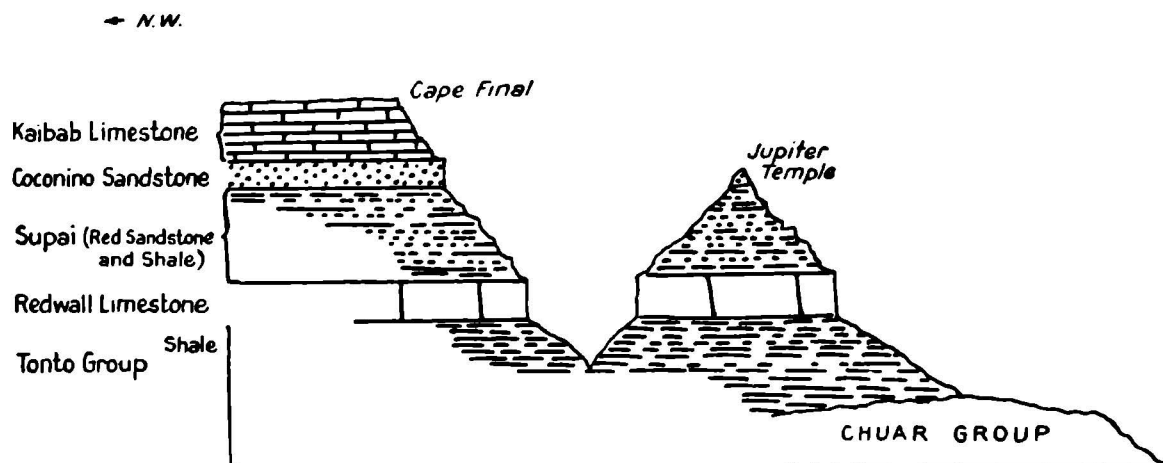
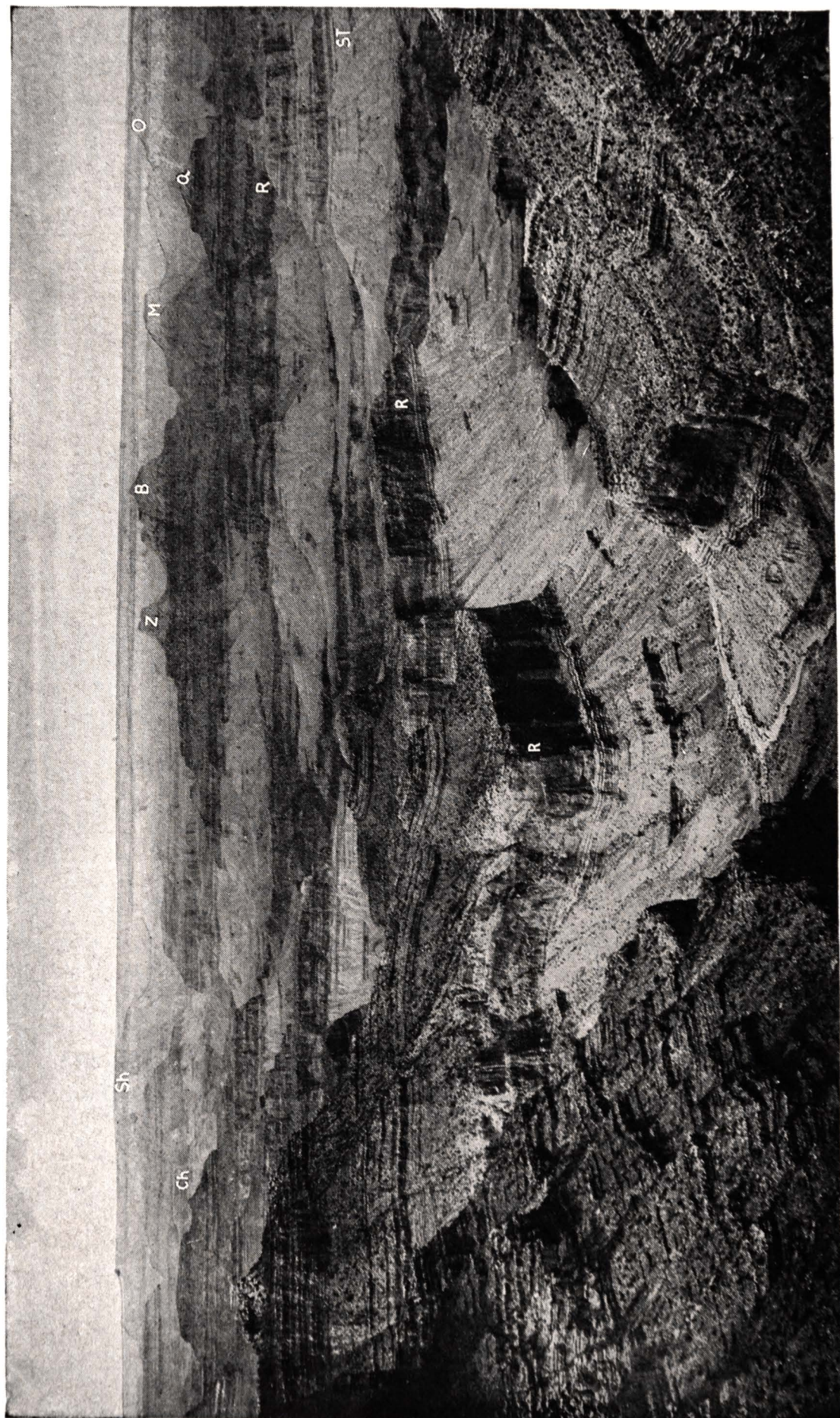


FIGURE 12  
Section of Rocks at Cape Final and Jupiter Temple





LOOKING UP GRAND CANYON FROM GRAND VIEW, POINT SUBLIME IN DISTANCE TO LEFT  
O—Obi Point on east side of Bright Angel Canyon, Sh—Shiva Temple (Kaibab Cap), CH—Cheops Temple (Redwall),  
Z—Zoroaster Temple, B—Brahma Temple, M—Manu Temple, all capped by Kaibab Limestone, A—Angel's Gate (Coconino),  
R—Redwall Limestone, ST—Shale Slope (Tonto) to T, Tonto Shelf, G—Granite. Note tilt of beds to left of  
middle of view; elsewhere nearly horizontal.



the south wall of the canyon, while the north wall shows superb cliffs with numerous projecting ridges and outlying temples and castles of great diversity. To the north-east may be seen the cliffs of the eastern corner of Walhalla Plateau just before its sharp northward turn. The projecting point at this turn is called Cape Final.

Between it and the onlooker is a pointed butte, 7 miles away, looking like a pyramid from this point of view. This is Vishnu Temple. It can be recognized by its squarish Redwall base, its step-like slopes of red

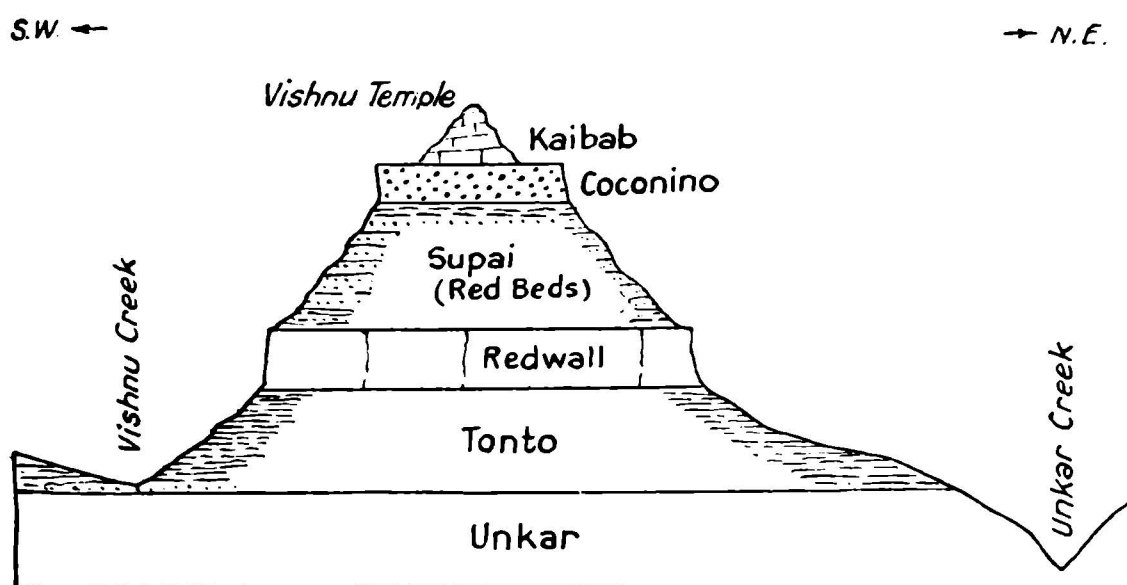


FIGURE 13  
Section Through Vishnu Temple

Supai bed, and its pointed pyramidal top of Coconino sandstone with its capping of resistant Kaibab limestone. These beds are shown in Figure 13.

To the immediate right of Vishnu Temple is a flat-topped mesa-like butte of red Supai beds on buttresses of Redwall limestone. This is Rama Shrine from whose dome the last protecting mass of harder Kaibab limestone and Coconino sandstone has long since been eroded away. This same process has removed the Kaibab limestone from Freya Castle to the left of Vishnu Temple.

Beyond the summit of Coconino sandstone capping Freya Castle can be seen the majestic front of the Walhalla Plateau. Its southernmost projection here is named Cape Royal. It is a dominating feature from many view-



points and if the shadows are right it can be seen in all its prominence from Grand View. From Cape Royal, an irregular ridge at somewhat lower level leads the eye to an isolated remnant of the plateau, named Wotan's Throne, a high terraced mesa 2 miles north of Vishnu Temple. It can be seen from most view points, even those far west of El Tovar. Extending southwest from Wotan's Throne is a ridge consisting of a huge pile of red sandstones and shales of the Supai formation, surmounting magnificent cliffs of Redwall limestone which extend far out in prominent buttresses and are deeply recessed by many alcoves. On the apex of this ridge are three small pinnacled outliers of the gray Coconino sandstone, two of which are known as The Angel's Gate.

Farther northwest across Clear Creek Canyon and Ottoman Amphitheatre are the superb series of eminences known as Zoroaster, Brahma, and Deva Temples. They are pinnacles on the ridge which extends south from Obi Point, the southwestern termination of Walhalla Plateau and beyond which flows Bright Angel Creek. These three temples are capped by outliers of Kaibab limestone, there being nearly 400 feet of this rock on Brahma Temple. Lower down and seeming very nearby in comparison, are Newberry Butte, Sheba Temple and Solomon Temple, flat-topped mesas consisting of outliers of the Redwall limestone.

Along the center of the vast abyss of the canyon and stretching far to the northwest, is the dark strip of the granite gorge, its walls descending in rugged cliffs from the Tonto platform. The east end of this granite gorge is in full view to the northeast at the foot of the Grand View slope. To the eastward the gorge gives place to the broad valley exposing rocks of the Unkar group, with many cliffs and high ridges showing the dark quartzites, red shales, and gray limestones, in an area that extends far to the northward. These rocks are not horizontal but dip to the east, while the shales of the Tonto group lie across their irregular surface, burying hills and valleys of a former land surface of great antiquity. In places the columnar edge of a sheet of basalt projects from between the Unkar beds. This basalt was forced between



the layers in a molten condition and the columnar structure developed as the material cooled. At one locality where the limestone was cut by the basalt, the heat developed asbestos, which is extensively used in making fireproof fabrics. The quality of the asbestos at this place is very good and an attempt was made to mine it. Material from the opening made in this mining operation may be discerned low in the slope on the north side of the river just below Grand View Point.

Far to the northeast beyond the great Unkar area, may be seen Cape Solitude. This is a point on the long line of cliffs constituting the western edge of the Painted

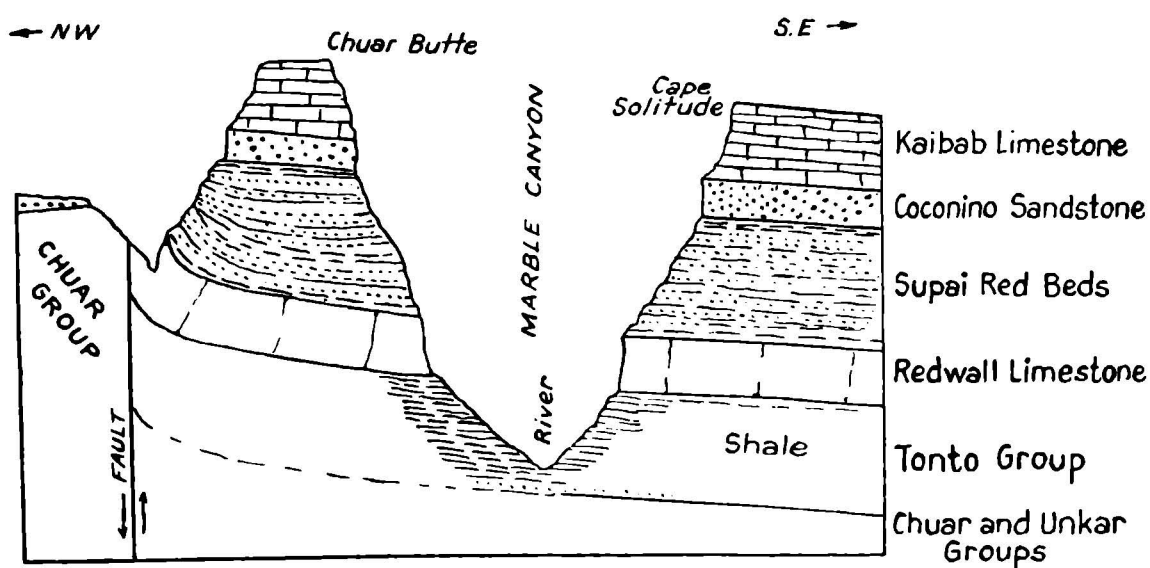


FIGURE 14  
Section Across Marble Canyon Just South of the Mouth  
of the Little Colorado River

Desert, at the south portal of the canyon through which the Little Colorado River flows to join the Colorado River, near the south end of Marble Canyon.

Extending east and west from Grand View Point is the irregular margin of the Coconino Plateau, forming the south rim of the Grand Canyon. This edge has numerous projecting points and certain outlying masses of Kaibab limestone. The first of these to the east is Three Castles, then follow Coronado Butte, Moran Point, Zuni Point, and many others.

Lower in the canyon are many prominent spurs carved in the red sandstones and shales of the Supai formation; still lower are the flat-topped ridges of Red-



wall limestone terminating in a 500-foot cliff, usually showing the full thickness of the formation. Lyell Butte and Newton Butte behind it to the northwest are two prominent piles of red Supai beds, which, it will be noticed, here have a decided dip to the northeast, as shown in Figure 15.

Of the Redwall shelves a particularly extensive and well marked one is the Horseshoe Mesa which juts far out into the canyon just below Grand View Point. A trail descends from the Point to this mesa and thence down the Tonto slopes to the Tonto platform where it joins a trail that is continuous all along the sandstone

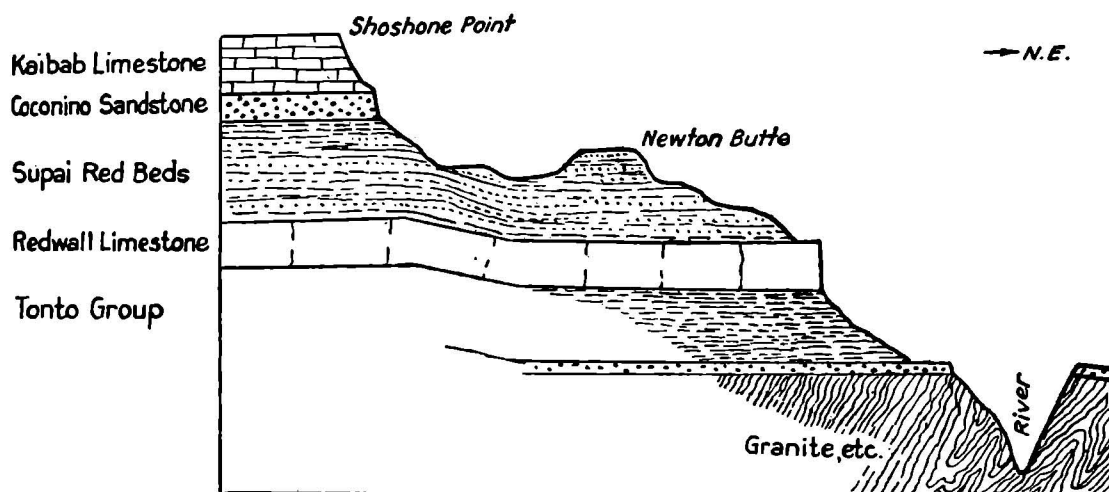


FIGURE 15  
Section From Shoshone Point to Colorado River

shelf westward to the Indian Gardens. This trail from Grand View is known as the Grand View Trail. It leads to an abandoned copper mine, the building of which can be seen on the saddle between Horseshoe Mesa and the long slope of red Supai beds to the rear. This latter slope exhibits nicely the difference in hardness between the Supai layers, the hard sandstones forming terraces and steps and the soft shales intervening in slopes partly covered by blocks fallen from the harder layers above.

Coronado Butte gives a good exhibition of the geologic succession from the shales of the Tonto group far below to the Kaibab limestone at the top. In the Redwall cliff can be noted the occasional round caves and deep alcoves characteristic of that formation. Next above rise the red steps of hard sandstones and slopes of



intervening softer shales of the Supai; then comes the cross-bedded Coconino sandstone, and above all a camel-shaped mass of Kaibab limestone. The layer of hard limestone forming the platform on which this camel lies is the basal member of the Kaibab limestone; it is well displayed in the wall behind Coronado Butte, and is always recognizable in the same relative position everywhere on both sides of the canyon.

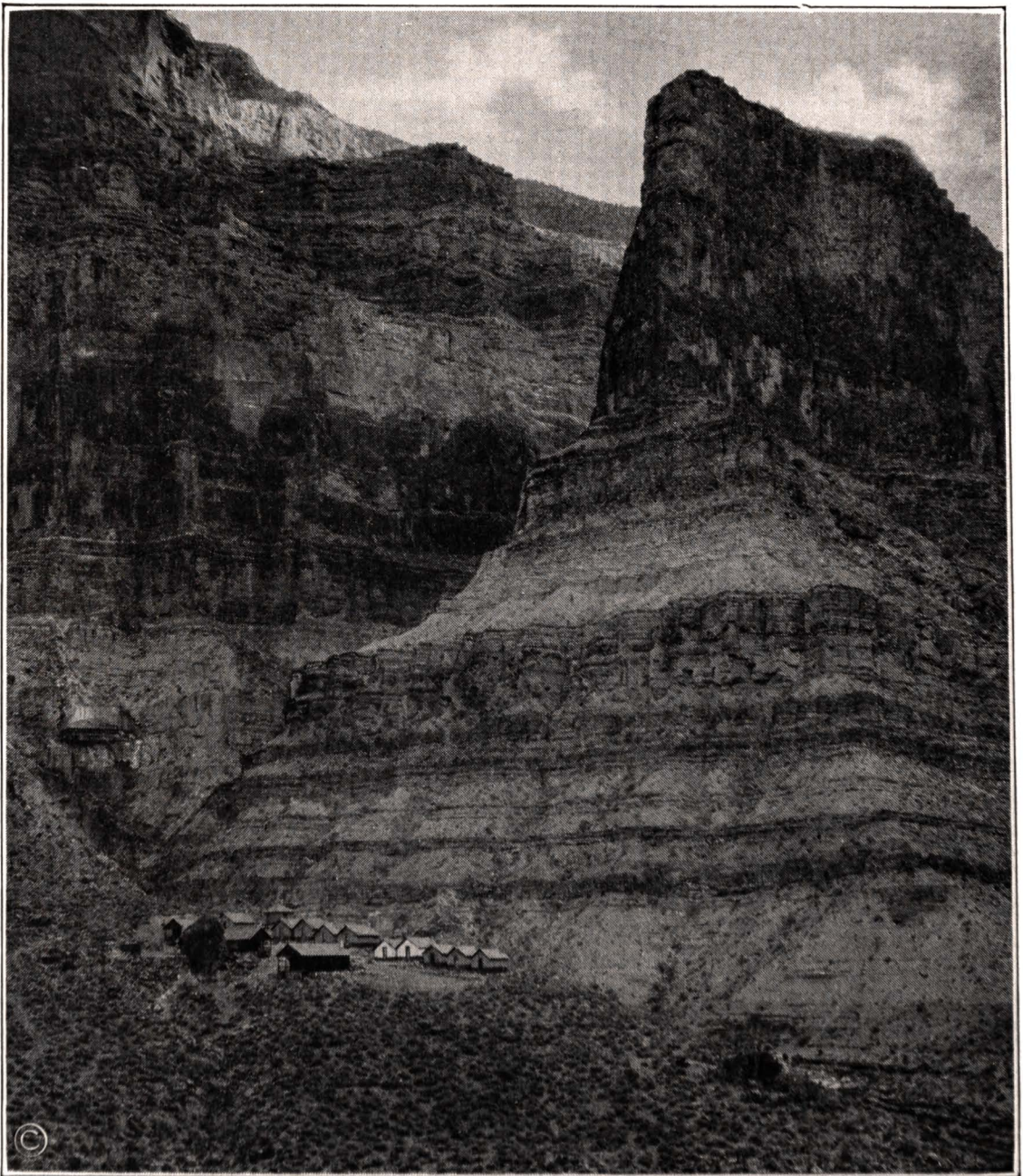
These upper formations can be well studied at close range in the deep recess at the immediate right (south-east) of Grand View Point. The exposures are particularly clear in the big drop-off at the head of which stands the building which was formerly used as the Grand View Hotel. At the top of this drop-off is the Kaibab limestone constituting the forested plateau. Its material was deposited by water in even beds, a feature clearly discernible. In one high projecting cliff toward the top is a porthole or window, due to the solution of the rock, for limestone is slightly soluble in water. This process is the cause of the frequent caves, large and small, in areas underlain by Kaibab limestone. The pitted surface of this limestone on Grand View Point and most other places and the deep fissures seen in the cliffs in many localities are due to this solvent action. It has been an important factor in carving many parts of the canyon, for solution not only carries away the rock but causes undermining of the ledges, a result that has much to do with keeping the upper edges of the canyon so precipitous.

The great mass of Coconino sandstone that forms a cliff below the Kaibab limestone all along the canyon wall, can here be observed to advantage. The characteristic cross-bedding is easily recognizable. It indicates deposition by strong currents which shifted irregularly as they deposited their sandy load. The Supai red beds already described lie beneath this cross-bedded Coconino sandstone, but they are too far below the viewpoint for close inspection.

One might imagine that much water was required for the cutting of this gigantic recess. On the contrary it has all been done by a small water course, dry for the

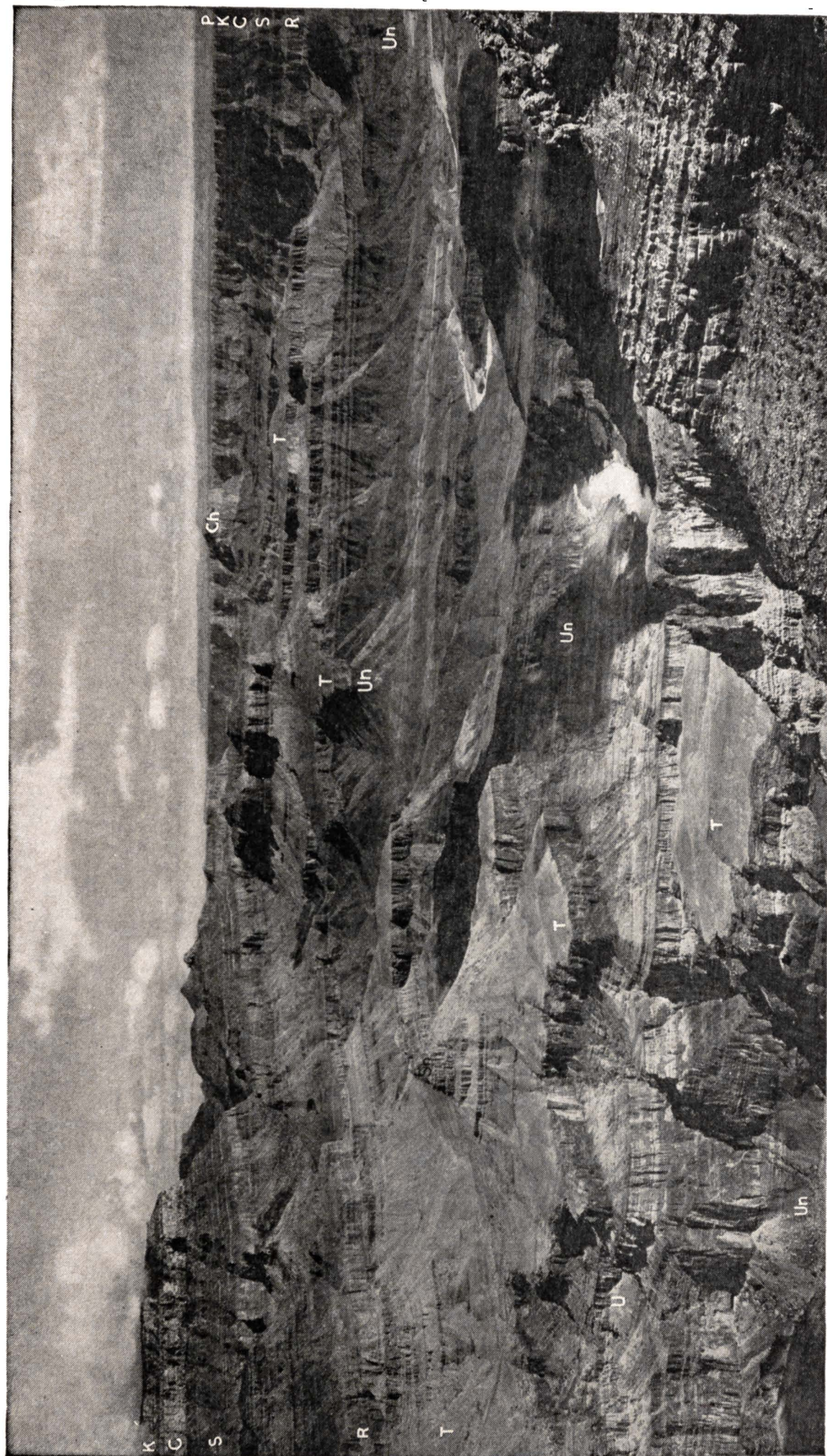
greater part of the year. The declivity is so great that the small but vigorous torrent caused by rain achieves a large result. As the ledges are undermined the rocks fall off in large masses and break to fragments on the steep slopes below.

Looking east from Grand View Point the local tilting of the strata can be well seen ; likewise in the ridges northwest. It is an unusual feature and is due to bending along a line which extends for many miles across the plateau to the south.



HERMIT CAMP, 2,500 FEET BELOW THE RIM





LOOKING NORTHEAST UP GRAND CANYON FROM ZUNI POINT, CAPE FINAL TO LEFT

J—Jupiter Temple; Ch—Chuar Butte opposite mouth of Little Colorado River, P—Painted Desert, K—Kaibab Limestone, C—Coconino Sandstone, S—Red Beds of Supai Formation, R—Redwall Limestone, T—Tonto group, nearly horizontal, lying on tilted Beds of Un, Unkar Group.



## THE HERMIT TRAIL

The trail down the Hermit Basin into the Grand Canyon west of El Tovar gives access to many notable scenic features and to a locality where the relations of the rocks are particularly well exposed. The road leads from El Tovar Hotel to some buildings on the rim at the head of Hermit Basin, where animals and guides are provided for the descent to the Tonto Platform, 3,500 feet below. The succession of rocks is shown in Figure 16.

The first stage of the descent is down long slopes, past many cliffs of the outcropping edges of the Kaibab limestone, here about 600 feet thick. The great cliff of Coconino gray sandstone is a prominent feature on all sides of the basin, but a talus slope and some deep rock cuts give the traveler an easy trail down this part of the course. Then there are long slopes with many twists down great sandstone steps across a thousand feet or more of the red beds of Supai formation. This brings the trail to the Redwall limestone which presents a cliff fully 500 feet high at nearly all points, but here again piles of talus and the numerous rock cuts of the "Cathedral Stairs" give an easy descent onto the long slopes of the shales of the Tonto group below.

The canyon of Hermit Creek is full of picturesque details and when the bench of the Tonto sandstone is gained there are splendid views up and down the canyon

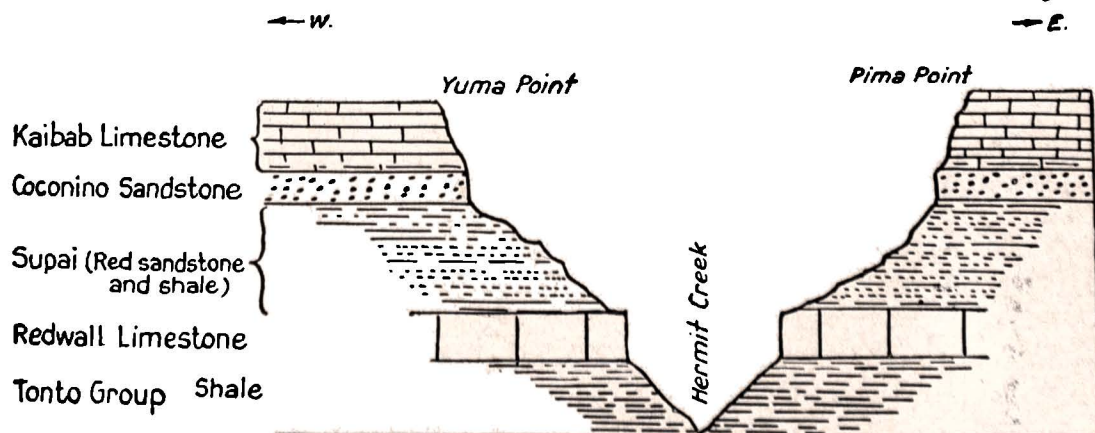


FIGURE 16  
Section Across Hermit Basin From Yuma Point to Pima Point



as well as into the granite gorge, which is here about 800 feet deep. Cope Butte, a long vertical-walled buttress of Redwall limestone, rises steeply to the east, and Marsh Butte, a promontory of closely similar character projects conspicuously 3 miles northwest. On the opposite side of the gorge and seemingly very near there is a particularly picturesque ridge culminating in the pinnacles known as the Tower of Ra, Osiris Temple, Horus Temple, and the Tower of Set, which have been referred to on a previous page.

Farther northwest are Mencius Temple and Confucius Temple capped by the basal member of the Kaibab limestone on the full thickness of the Coconino sandstone. Farther in the distance rises Point Sublime, the great projection at the south end of this portion of the Kaibab Plateau.

From the camp at the lower end of the trail it is practicable to proceed eastward along the Tonto shelf to the Indian Gardens, and ascend to the plateau again by the Bright Angel Trail.



HERMIT'S REST



## THE VIEW FROM POINTS FAR TO THE WEST

There are many "points" jutting out from the south wall of the canyon west of Hermit Basin, some of which afford superb views of the great chasm and reveal features not visible farther east. Unfortunately, however, these points are some distance from roads and trails and are therefore not convenient to visit. Havasupai Point, Fossil Mountain, and Grand Scenic Divide, all near Bass Camp, 25 miles northwest of El Tovar, have splendid outlooks into a portion of the canyon full of novelty.

To the north is Powell Plateau, an imposing promontory of the north side plateau projecting far to the southwestward. At its southeastern end is Dutton Point with great precipices of Kaibab limestone and gray Coconino sandstone with huge steps of Supai red sandstone below. At the southern end of Powell Plateau is Wheeler Point and, farther west, Ives Point, all presenting the same succession of rocks as in Dutton Point. The Granite Gorge extends west past these points, but it ends as the hard "granite" finally pitches down and disappears at the big bend in the river south of Powell Plateau.

Opposite Havasupai Point and Grand Scenic Divide the north side of the canyon is broken by the profound side canyon of Shinumo Creek and its many branches, which is known as Shinumo Amphitheatre. These canyons cut the slope into an intricate maze of promontories, rising into numerous pinnacles of red Supai rocks, capped in places by masses of gray Coconino sandstone and a few small remnants of the lower part of the Kaibab limestone.

In the depths of the canyon of Shinumo Creek and along the sides of the Grand Canyon near the mouth of that creek there may be seen a huge mass of dark sandstones, limestones and red shales of the Unkar group lying on the granite. The Unkar beds are considerably tilted and broken by many faults.



## THE NORTH RIM OF THE CANYON

From every point of view it will be seen that the north rim of the canyon consists of the Kaibab limestone supporting a luxuriant forest which makes the horizon to the north and northwest. This is the southern edge of the great Kaibab plateau which extends north into Utah. About 40 miles north upon this great plateau there rise cliffs of the younger formations above the Kaibab limestone. Ages ago these formations entirely covered the present plateau, but now, with the exception of a few scattered remnants still persisting as high buttes south of the canyon, these vast accumulations of millions of years have vanished from the canyon region.

Like the southern rim, the northern rim is rapidly wearing away under the elements. It will be noted, however, that the north wall is more deeply trenched by side canyons than the south wall. This is due to the fact that it is more than 1,000 feet higher, for the Kaibab limestone which once stretched solidly across the space now canyoned by the river, sloped gradually upward to the north. The greater elevation on the north side gives increased rainfall and greater declivity, which means more cutting power to the streams. On the south wall, in addition to much less precipitation, the slope of the limestone surface to the south results in a drainage to the south. Thus, immediately back from the edge of the cliff whatever rain or water there is flows away from the canyon. This fact is largely the cause of the lack of underground waters in sufficient quantity for domestic use.

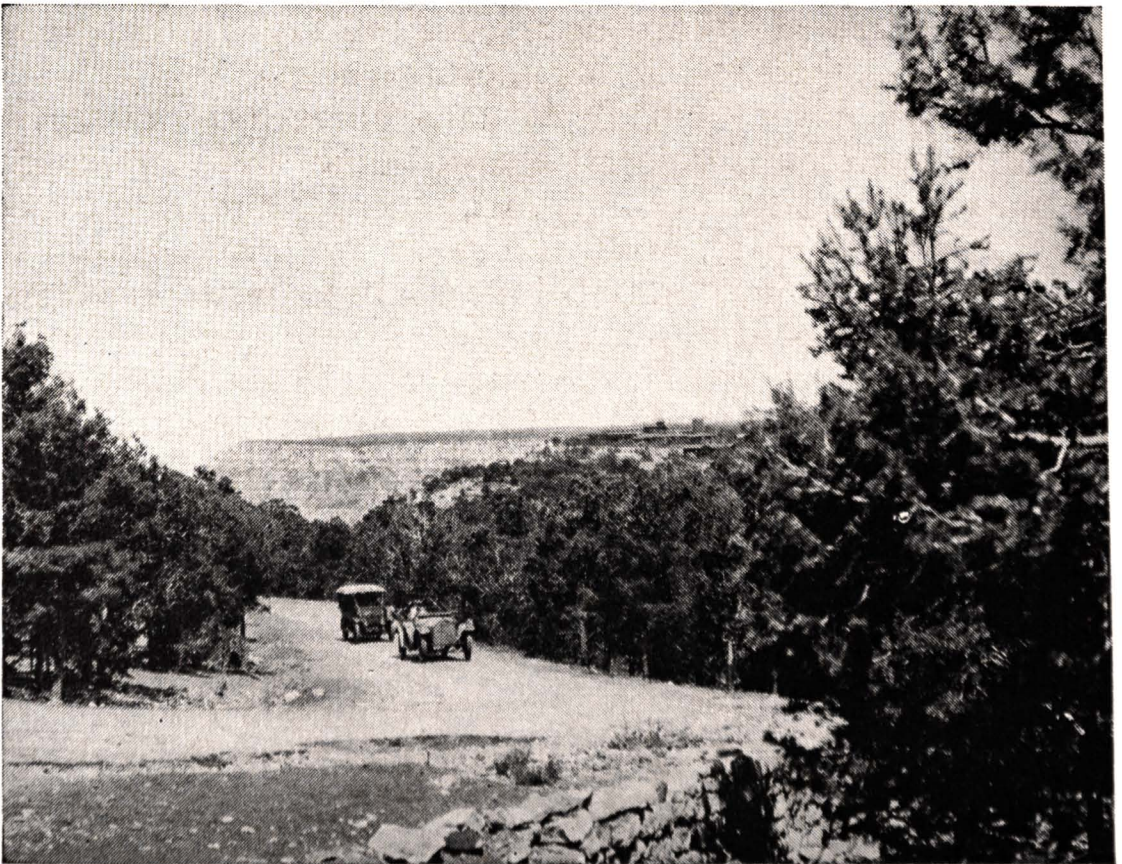
Of the many recesses on the north side there are two within view that are so long and deep that they have cut the face of the plateau in three great promontories. The most easterly of these is known as Walhalla Plateau. On its east lies Marble Canyon, through which the Colorado River forces its way before its westerly turn through the Grand Canyon; on its left is Bright Angel Canyon. The easterly point of Walhalla Plateau is Cape Final; its



southerly point is known as Cape Royal. Both of these magnificent capes can be seen from Grand View, and Cape Royal is visible for many miles west. On its westerly side toward Bright Angel Creek, Walhalla Plateau terminates in Obi Point.

Immediately north of El Tovar lies the extensive promontory formed by Bright Angel Canyon on the east and Shinumo Amphitheatre on the west. This portion of the great plateau retains the name Kaibab; its southwesterly point is fittingly designated Point Sublime.

Beyond Shinumo Amphitheatre another great promontory bears the name Powell Plateau in memory of the intrepid explorer.



HERMIT RIM ROAD

## FROM DESERT VIEW

Desert View is a resort developed on Navaho Point about 20 miles east of El Tovar. It affords a nearby view of the Painted Desert and a unique panorama of the big bend of the Grand Canyon. It is easily reached by an excellent road which branches from the main highway at Grand View and, continuing through the Coconino Forest, affords several fine outlooks into the Canyon before reaching the splendid vista at its terminus.

Navaho Point is a projection of the south rim about 10 miles east of Grand View. Its position is most advantageous, since it projects into the great corner where the canyon turns from its southerly to its westward course, and also has a commanding height over all adjoining portions of the rim.

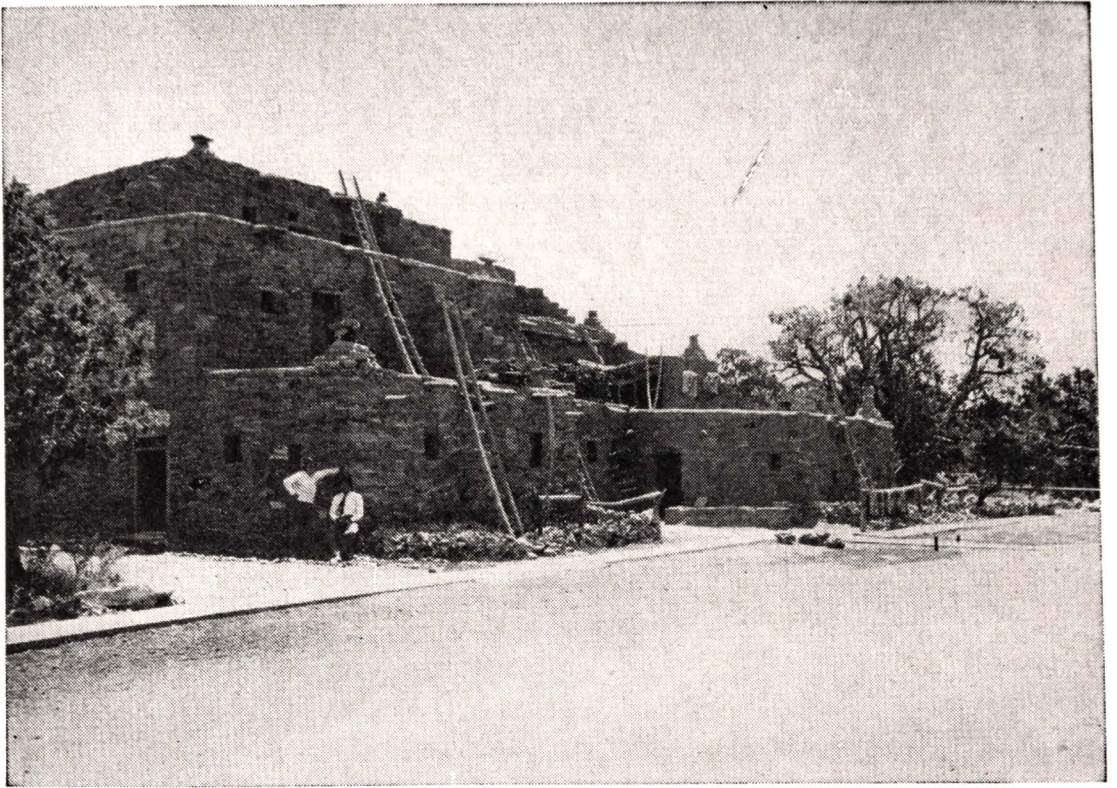
To the north is a great outlook far up the Marble Canyon, beyond which, on the distant horizon, is the long gray line of Echo Cliffs, extending to Utah. To the northwest are revealed many superb features of the edge of the Walhalla Plateau, with its wonderful display of outlying "temples," notably Jupiter and Vishnu.

Westward there is a most comprehensive view down the canyon from the beginning of the granite gorge to beyond Yaki Point; while far away may be discerned the volcanic peaks of Mount Trumbull in the Toroweap region, 65 miles west of El Tovar—remains of craters which formerly poured out streams of lava, some of which descended to the bottom of the canyon.

To the south across the great forest of the Coconino Plateau rises the great pile of volcanic eruptions culminating in the San Francisco Peaks.

Navaho Point affords the most comprehensive view of the Painted Desert to be had from the south rim. It extends far to the east from the edge of the canyon, in a succession of low steps banded by the red strata of the Moenkopi formation, and the low brown cliffs of Shinarump conglomerate, merging into light-colored slopes of





THE HOPI HOUSE, A MINIATURE INDIAN PUEBLO

the Chinlee formation which extend to distant sandstone-capped buttes and mesas on which Walpi and the other Hopi Indian villages are built. Still farther to the northwest, the lofty conical summit of Navaho Mountain, near the southern margin of Utah, is usually discernible.

On the horizon to the north are the Echo Cliffs, a succession of Moenkopi and overlying strata. On a line just east of them, but much nearer the observer, stands a flat-topped butte known as Shinumo Altar, rising prominently above the general level of the Painted Desert; this is a remnant of the great thickness of Moenkopi formation which once covered all of the plateau. Cedar Mountain, the conspicuous butte on the Painted Desert just three miles east of Desert View, is likewise a remnant of this formation.

To the northeast a deep gash can be detected cutting sharply across the Painted Desert. This is the canyon of the Little Colorado River which joins the main stream just beyond Cape Solitude, ten miles north of Desert View. At this point the Colorado River is flow-

ing through Marble Canyon, a very steep-walled gorge, which opens into the broader valley a few miles below the mouth of the Little Colorado.

Looking into the canyon from Desert View, the same distinctive features of most of the great rock masses seen in other localities are everywhere apparent. However, the relations in the lowest part of the canyon are very different. The river, on leaving Marble Canyon, reaches the softer beds of the Unkar formation, in which it has formed a wide valley which continues to the point of contact with the granite north of Grand View, where the sharply cut "granite gorge" begins. This deep-lying inner valley of the Unkar rock is bordered with rolling hills and sloping ridges of moderate height in which red tints predominate; the rocks consist of red shales and gray to brown sandstones.

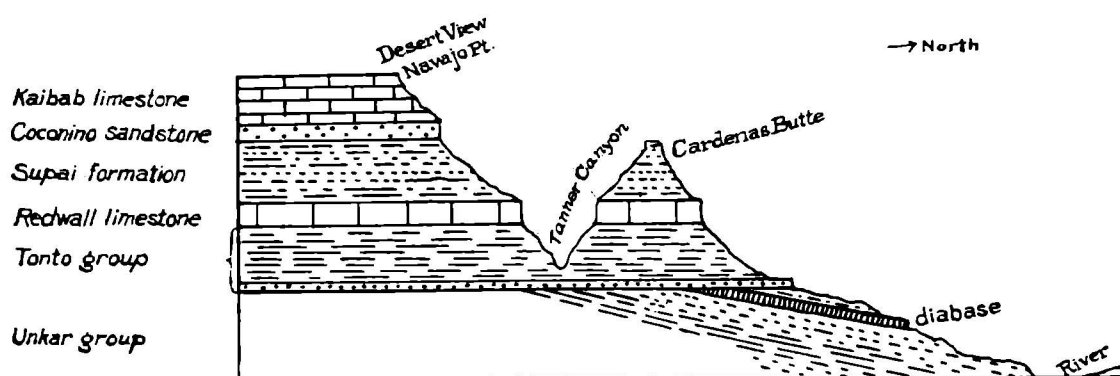


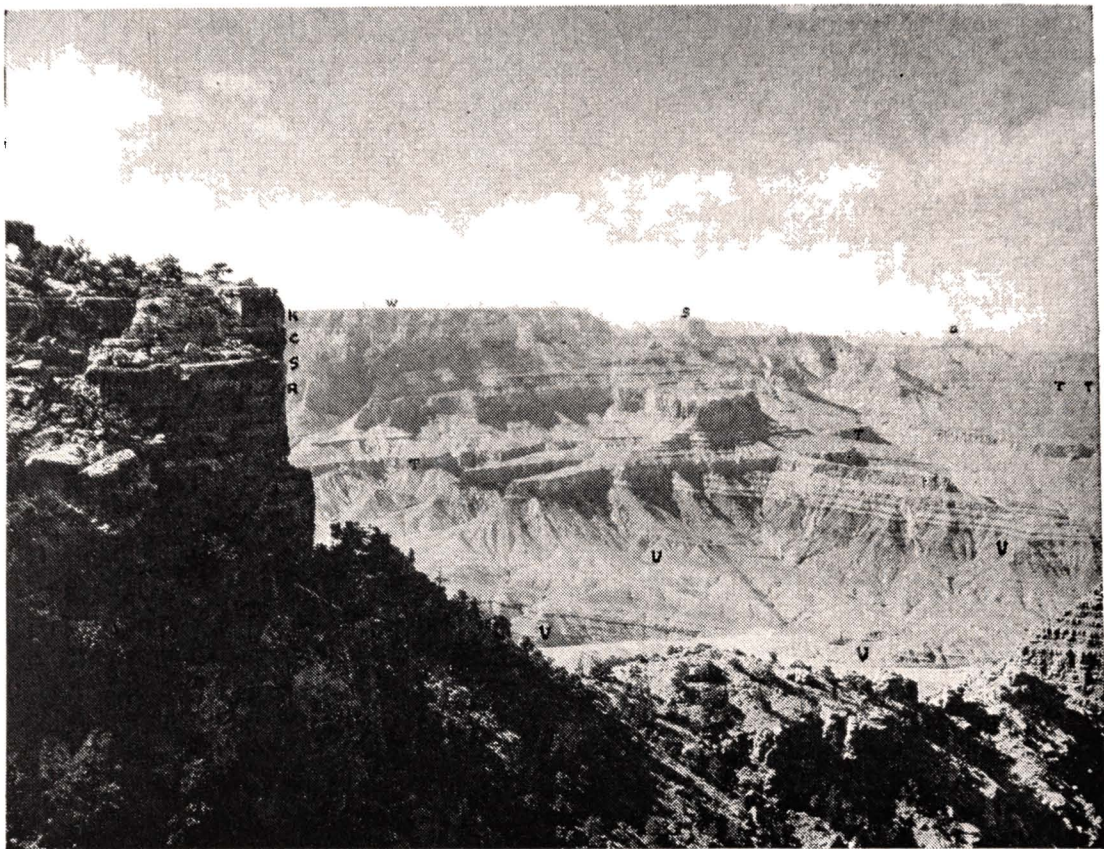
FIGURE 17

Section of South Side of Grand Canyon at Navaho Point

Several lines of conspicuous black cliffs will be noted, due to sheets of diabase in a molten condition having been intruded between certain layers of the Unkar beds. The Unkar rocks, in addition to being much faulted, dip at moderate angles to the east and northeast in strong contrast to the nearly horizontal attitude of the overlying strata which lie across their edges. This discrepancy of dip is well brought out in the view on page 68.

This valley is enclosed by the same array of buttes, ridges, precipices and buttresses, as in other portions of the canyon. The Tonto rocks are well represented by the characteristic shelf of the basal sandstone present at most places, and by long slopes of the overlying shales.





#### LOOKING NORTHWEST FROM DESERT VIEW

W, Walhalla Plateau; S, Siegfried Pyre; G, Gunther Castle; K, Kaibab Limestone; C, Coconino Sandstone; S, Red Beds of Supai Formation; R, Redwall Limestone; T, Tonto Group lying unconformably on U, Unkar Group.

These rise to the great cliff of Redwall limestone which is everywhere conspicuous in the middle slope of the canyon walls; the Redwall also constitutes many of the lower projecting buttresses and outlying buttes, notably Sheba Temple and Solomon Temple.

The red shales and sandstones of Supai formation have great prominence in this portion of the canyon, especially in the ridges that bear the varied groups of "temples," "shrines" and "castles," as, for example, the splendid ridges culminating in Vishnu Temple, Jupiter Temple, Siegfried Pyre, Gunther Castle and that which bears Cardenas and Escalante buttes at the observer's feet. The great pagoda-like mass of Vishnu Temple, to the west, (see Figure 13), and the majestic square-topped Siegfried Pyre, far to the north-northwest, bear caps of Coconino sandstone and small remnants of the lower part of the Kaibab limestone.

On Jupiter Temple, however, to the northwest, and Escalante Butte, only a thin mass of the Coconino sandstone remains. In the upper wall of the canyon the persistent gray cliff of the Coconino sandstone is everywhere conspicuous, capped by the thick sheet of Kaibab limestone constituting the general plateau. Some notable projecting points of the Walhalla Plateau (which is merely a south-easterly extension of the Kaibab Plateau) are Cape Final and Cape Royal, northwest of Desert View. Wotan's Throne, still farther west, is an outlying portion of this northern plateau.

It will be noted that there is a gradual general rise of the plateau strata to the east or northeast, as far as a north and south axis line passing through Navaho Point, beyond which they make a rapid descent to the east. A sharp downward bend in the alcove in the rim is well exposed in the cliffs a mile east of Desert View—a roll in the strata which extends far to the south. Looking north toward the buttes between Cape Final and Cape Solitude, this downward bending of the strata is clearly in view in places as shown in figure 14 on page 55, with local steep dips and considerable faulting.

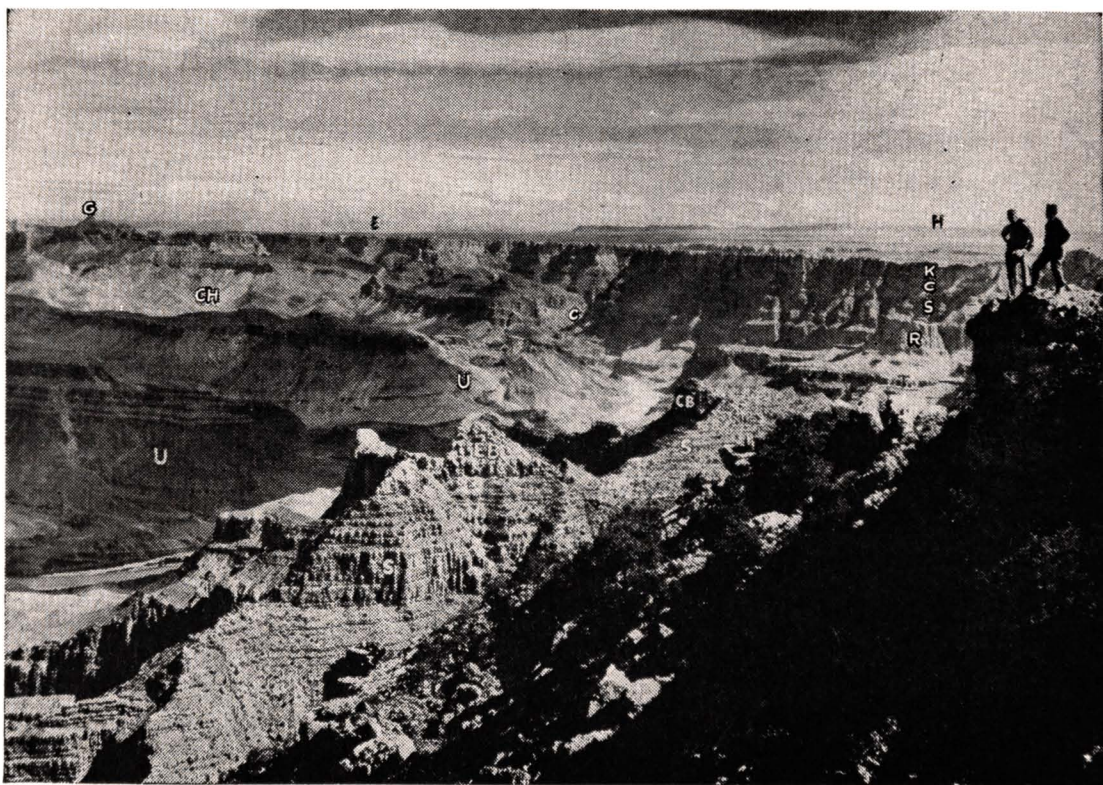
In Cape Final the top of the Kaibab limestone of the plateau reaches an altitude of 7,919 feet, while in Cape Solitude, about seven miles distant, it has descended to an altitude of 6,167 feet, and this slope of the beds, continuing to the east, finally carries this limestone far beneath the Moenkopi and other younger formations in the central and eastern portions of the Painted Desert.



## FROM LIPAN POINT

Lipan Point is a high knob on the south rim on a short but steep spur of the road from Grand View to Desert View. From it an exceptionally fine view of the canyon may be obtained.

All the features in sight are visible from Desert View, which has the advantage of being 100 feet higher and nearly two miles farther east. When convenient,



LOOKING NORTH FROM LIPAN POINT

Junction of the Little Colorado River and Marble Canyon at C. Echo Cliffs, E, beyond Painted Desert, and Hopi Buttes, H; G, Gunther Castle; C. B., Cardenas Butte; E. B., Escalante Butte; K, Kaibab Limestone; C, Coconino Sandstone; S, Red Beds of Supai Formation; R, Redwall Limestone; T, Sandstone of Tonto group; U, Unkar beds; Ch, Chuar group. Note upturned strata at fault under E.

however, the short trip to Lipan Point is well worth while. There is also a fine view to the south over the forest-covered Coconino Plateau with the volcanic peaks of the San Francisco Mountains in the distance and an extended outlook over the great steppe-like plains of the Painted Desert.



## BRIGHT ANGEL CANYON

The trip up the canyon of Bright Angel Creek affords an intimate view of all the rocks of the Grand Canyon area, presented under unrivalled scenic conditions. There is an excellent horse trail from the suspension bridge across the river near the mouth of the creek,



PHANTOM RANCH, A MILE BELOW THE RIM

to the rim far back in the Kaibab Plateau. Many good camping places are available here, with an abundance of water from the creek.<sup>1</sup>

The lower part of the canyon is a gorge in the granite about 1,100 feet deep, with sides so steep that but

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<sup>1</sup>On the banks of the creek, about a quarter of a mile beyond the suspension bridge, Phantom Ranch has been established. The buildings for the accommodation of visitors are in the form of cabins constructed of the huge, multi-colored Canyon boulders. A "community house" in the center of the camp provides eating facilities and home comforts. The ranch is also an overnight stop on the rim-to-rim trip, being one day's journey from either rim of the Canyon.



little can be seen of the adjoining slopes and the huge steps rising 4,500 feet to Brahma Temple on the east and 4,200 feet to Buddha Temple on the west. At some unknown point in this part of Bright Angel Canyon the legendary "Sipapu" of the Hopi Indians is supposed to exist—a mysterious fissure through which, the Hopis believe, the original inhabitants are supposed to have come to this earth and through which the souls of all men must return to the underworld when they die. The surroundings lend color to the legend and the visitor, sitting outside his cabin at Phantom Ranch after sundown, can only characterize the atmosphere as wierd in the extreme. The Altar Falls, on Ribbon Creek and the swarms of jet black butterflies which haunt the locality for the most part of the year add realism to the

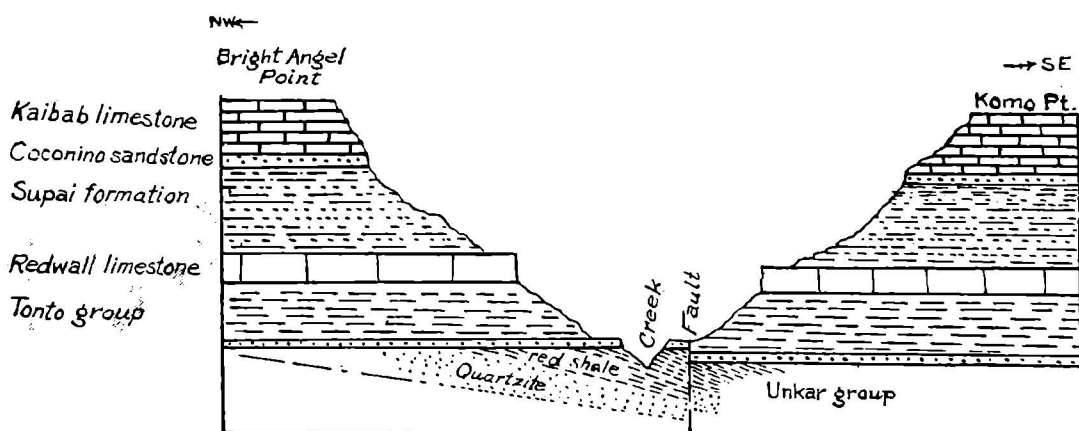


FIGURE 18

Section Across Bright Angel Canyon Near Bright Angel Point

myth. Farther up the creek, where the canyon is wider and margined by the plateau, superb castelated walls are presented, which, in Komo Point on the east, are 3,500 feet above the bottom of the canyon, and in Bright Angel Point on the west, 3,650 feet, with the relations shown in Figure 18.

The Unkar strata capping the ridge west of the lower portion of the canyon of Bright Angel Creek, are scarcely observable from the trail below, but at a point a mile above the mouth of Phantom Creek, the surface of the granite and schists sinks rapidly below another wedge of Unkar strata which constitutes the bottom and lower slopes of the canyon for the next four miles. These

Unkar beds dip at moderately steep angles to the north-eastward, and on their planed-off surface lies the basal sandstone of the Tonto group, overlain by the usual succession of plateau strata, as shown in Figures 18 and 19. The first members of the Unkar group are basal sandstones and conglomerates of no great thickness, above which is limestone. The latter is penetrated by a thick mass of black, igneous diabase which was intruded into these beds before their uplift, planation, and burial beneath the later formations. This diabase is conspicuous in the depths of the canyon and in its walls, up to the capping of the basal sandstones of the Tonto group, as shown in Figure 19.

In this vicinity there are occasional gaps in the canyon walls, cut by tributary streams, which give intimate glimpses of Buddha and Manu Temples on the west, and Zoroaster, Brahma and Deva Temples on the east—huge piles of strata from Tonto to Coconino and lower Kaibab. Near Altar Falls, on Ribbon Creek, four and one half miles up the canyon, the diabase is succeeded by thick bodies of quartzite and above the mouth of Wall Creek these quartzites in turn give place to the uppermost member of the Unkar group, mostly of red shale, which continues to the foot of Bright Angel Point. In this vicinity the basal sandstone of the Tonto group becomes the floor of the canyon for a short distance, with its relations somewhat complicated by a small fault with a drop on the east side. (See cross section of Figure 18.)

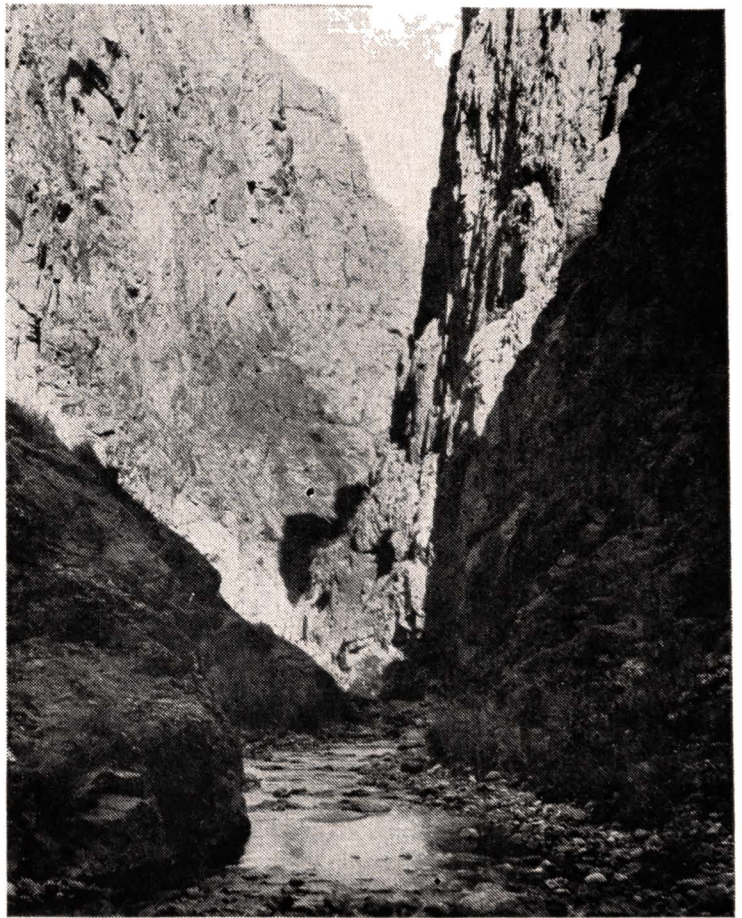
In this part of the canyon there are some wonderful vistas in side canyons which descend from the high plateau above and cut through all the strata from Kaibab limestone to the Tonto group. The sections in Komo Point observed from near the mouth of Wall Creek and the view up the Transept (a deep canyon just south of Bright Angel Point), are particularly impressive. The succession of cliffs from the creek to the top of Komo Point is one of the steepest in Grand Canyon, and the cliffs in the Transept are of the first order of magnitude.



The Redwall limestone, which thickens somewhat to the northward, rises in huge steps from the slopes of shale at the top of the Tonto and causes a vast zigzagging of the trail leading out of the canyon. Above it, the red beds of the Supai formation include a series of hard sandstone layers, causing numerous high steps leading to the base of the wall of gray Coconino sandstone, here considerably thinner than in the region near El Tovar.

As one ascends these steps of the Supai and the Coconino formations in the north end of Bright Angel Canyon, there are grand vistas to the south, showing a myriad of buttresses, alcoves and temples, in all their glowing beauty.

The final ascent from the top of the Coconino ledge to the top of the Kaibab limestone forming the plateau is a matter of only a few hundred feet by an easy trail. Once the Kaibab Plateau is attained one finds himself at the edge of a superb forest which extends for many miles northward. It is a region of great beauty, the forested area being interspersed with many charming parks where live deer and mountain lions in numbers sufficient to tempt the hunter.



PHANTOM CANYON

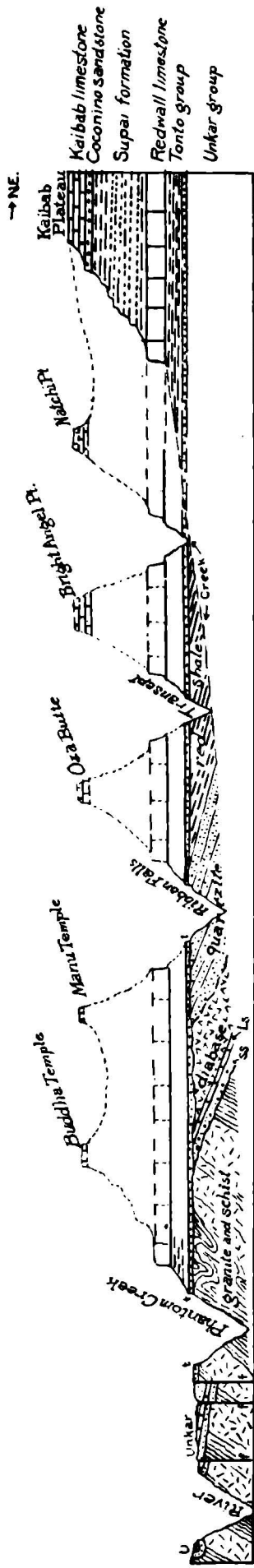


FIGURE 19  
SECTION ALONG BRIGHT ANGEL CREEK  
SS, Sandstone; LS, Limestone of Unkar Group, U; F, Fault; T, Basal Sandstone Tonto Group.

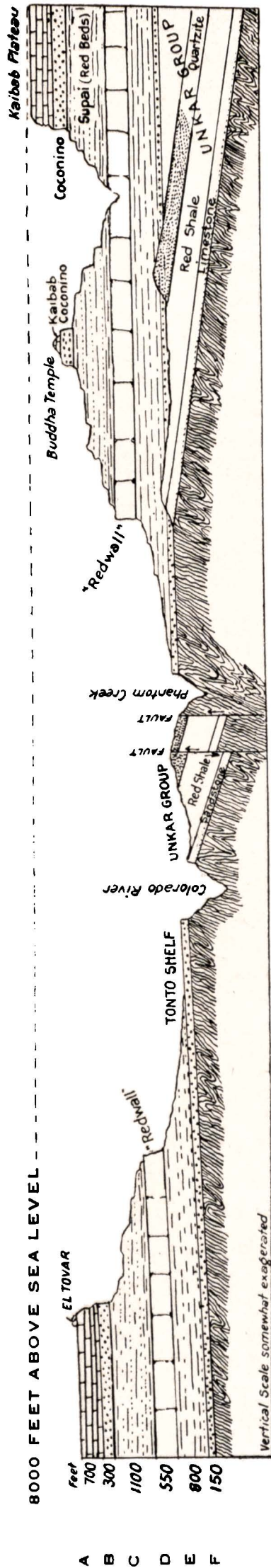


FIGURE 20  
SECTION ACROSS GRAND CANYON WEST OF BRIGHT ANGEL CREEK FROM EL TOVAR TO KAIBAB PLATEAU

- |   |                                   |   |                           |
|---|-----------------------------------|---|---------------------------|
| A | Kaibab Limestone                  | D | Redwall Limestone         |
| B | Coconino Sandstone                | E | Shales } Tonto            |
| C | Supai (Red Sandstones and Shales) | F | Sandstone } Granite, etc. |





MAP  
SHOWING CONFIGURATION  
OF THE  
**GRAND CANYON**  
FROM MAPS MADE BY  
F E MATTHES AND R T EVANS  
HACHURED BY  
A C ROBERTS  
1915



STATUTE MILES  
Note—The lines with numbers (7000, etc.) indicate elevation above sea level.  
From U. S. G. S. Bull. 413.







## DERIVATION OF NAMES USED ON GRAND CANYON MAPS

While some of them are purely descriptive, many commemorate scientists, explorers, Indian tribes, leaders of religion, mythologic and romantic personages. Aztec and Indian terms occur and the origin of a few names is unknown.

- Alarcon Terrace**—Spanish navigator, first to ascend the Colorado River.
- Apache Point**—A once warlike Indian tribe of Arizona and New Mexico.
- Apollo Temple**—The son of Jupiter and brother of Diana, god of the sun in Roman and Greek mythology.
- Awatubi Crest**—A Hopi village on the Painted Desert destroyed in 1770.
- Aztec Amphitheatre**—The general name of all tribes in Mexico at the time of Cortez.
- Bass Camp**—Owned by one of the pioneer settlers of the Grand Canyon region.
- Beale Point**—Army officer who surveyed the first road across the Arizona plateau.
- Brahma Temple**—In the Hindu triad Brahma was the evolver of the universe, Vishnu the redeemer, Shiva the destroyer.
- Buddha Temple**—The title of Siddhartha, founder of Buddhism in the fifth century B. C.
- Cardenas Butte**—A member of Coronado's party and the first white man to see the Grand Canyon.
- Castor Temple**—The devoted brother of Pollux in Greek mythology.
- Centeotl Point**—Probably an Aztec deity.
- Chemuhuevi Point**—The southermost of the Pinto tribe in Lower California.
- Cheop's Pyramid**—An Egyptian king of the fourth dynasty, builder of the famous pyramid at Gizeh.
- Chuas Butte and Creek**—Name of Indian Chief.
- Cocopa Point**—A tribe of Yuma Indians living on the Colorado River.
- Coconino Plateau**—A name sometimes used for the Havasupai, who originally occupied much of the Arizona plateau.
- Comanche Point**—Plains Indians from further east whose raids were greatly feared by the Pueblos.
- Confucius Temple**—The Chinese philosopher.
- Conquistador Aisle**—Spanish for "conqueror." The Conquistadores were especially the members of Coronado's expedition.
- Cope Butte**—A great American naturalist, specializing in fossil animals.
- Coronado Butte**—The Spanish captain who led an expedition through the Southwest in 1540.
- Dana Butte**—Noted professor of geology at Yale for many years.
- Darwin Plateau**—Named for the famous English naturalist who first expounded the theory of evolution.
- Deva Temple**—Divine epithet, applied commonly to goddess Durga, wife of Shiva of the Hindu triad.
- De Vaca Terrace**—Cabeza De Vaca was shipwrecked on the Gulf Coast and wandered for eight years among Indians before reaching a Spanish settlement.
- Diana Temple**—Roman goddess of the moon, sister to Apollo and daughter of Jupiter.
- Drummond Plateau**—A famous Scottish religious writer.
- Dutton Point**—Major C. E. Dutton, U. S. A., author of a monograph on the Grand Canyon.
- Elaine Castle**—The lily maid of Astolat in Tennyson's poem, "The Idylls of the King."
- Escalante Butte**—A Spanish priest who crossed the Arizona plateau in 1775.
- Excalibur**—The magical sword of King Arthur of the Round Table.
- Fiske Butte**—John Fiske, 1842-1901, American philosopher.
- Freya Castle**—In Scandinavian mythology, Freya is the goddess of love and womanly goodness.
- Galahad Castle**—The purest knight of the Round Table, featured in "The Idylls of the King."
- Garces Terrace**—A Franciscan who journeyed through the Hopi country in 1776.
- Gawain Abyss**—Gawain the Courteous, one of the principal knights of the Round Table.
- Geikie Peak**—Sir Archibald Geikie, for many years director of the British Geological Survey.

**Guinevere Castle**—The wife of King Arthur of the Round Table.

**Gunther Castle**—The Burgundian king of the Nibelungen epic, husband of Brunnhilde.

**Hance Creek**—John Hance, a local character and pioneer.

**Havasupai Point**—This tribe, formerly occupying Arizona plateau, now live in Cataract Canyon, about sixty miles from El Tovar.

**Holy Grail Temple**—The cup used at the Last Supper, which the order of the Round Table was instituted to protect.

**Horus, Temple of**—In Egyptian mythology, the son of Osiris and Isis, principal dieties.

**Hopi Point**—The Hopis, sometimes called the Moquis, have maintained villages overlooking the Painted Desert since long before the Spanish invasion of 1540.

**Mount Huethewali**—Indian word for observation point.

**Huxley Terrace**—Named for the famous English biologist.

**Isis Temple**—Principal female diety of Egypt, wife of Osiris, mother of Horus and sometimes called "the daughter of Ra."

**Ives' Point**—Named for Lieutenant Ives, leader of the Colorado River exploration, 1857-58.

**Jicarillo Point**—An Apache tribe of northwestern New Mexico.

**Juno Temple**—Wife and sister of Jupiter, queen of heaven in Roman mythology.

**Jupiter Temple**—The supreme diety of the Romans.

**Kaibab Plateau**—Piute word meaning "mountain lying down."

**King Crest**—Named for the first director of the U. S. Geological Survey.

**King Arthur Castle**—A British king of the sixth century who, with his knights of the Round Table, has served as the inspiration for much poetry and romance.

**Krishna Shrine**—In Hindu mythology Krishna is the name of the eighth of the ten incarnations of the supreme god Vishnu. The ninth was in the form of Buddha; the tenth is still to come.

**Kwagunt Butte and Creek**—Probably a Shoshonean name.

**Lancelot Point**—A knight of the Round Table, featured in Tennyson's poem, "The Idylls of the King."

**Leconte Plateau**—Named for a professor of geology in the University of California.

**Lipan Point**—An Apache tribe.

**Lyell Butte**—A famous English geologist.

**Manu Temple**—A sanskrit word meaning man, one of fourteen demiurgic beings, each of whom presided over a period of race progression. Manu Vaivasvata, the sun-born, is the manu of the present race of beings.

**Marcos Terrace**—Fray Marcos de Niza led the first expedition into our country from Mexico in 1539, as far as Zuni. His accounts inspired Coronado's exploration.

**Maricopa Point**—A tribe of Yuma Indians who moved from the Colorado River to join the Pimas.

**Marsh Butte**—O. C. Marsh, the paleontologist, who made a specialty of extinct animals.

**Mencius Temple**—The Latin name of the Chinese philosopher, Meng, a famous early Confucian.

**Marlin Abyss**—A semi-legendary character of the fifth century who figures in Tennyson's "Idylls of the King."

**Mescalero Point**—An Apache tribe that roamed principally in New Mexico.

**Mimbreno Point**—An Apache tribe taking its name from the Mimbres Mountains in New Mexico.

**Modred Abyss**—The treacherous nephew of King Arthur, knight of the Round Table.

**Mohave Point**—A Yuma tribe living in the vicinity of Needles, California.

**Montezuma Point**—The ruler of the Aztecs at the time of the Spanish conquest. By later Indians he was regarded as a diety.

**Moran Point**—The most noted painter of the Grand Canyon, who accompanied Major Powell in his survey of the Colorado River in 1873.

**Natchi Point**—A noted Apache warrior.

**Navaho Point**—Nomadic Indians of the plateau region who maintained a long warfare against Pueblos and whites.

**Newberry Point and Butte**—The geologist on the Ives expedition.

**Newton Butte**—Famous English scientist, discoverer of the law of gravitation.

**O'Neill Butte**—A former governor of Arizona.

**Osiris**—Chief Egyptian diety of good, closely associated with Ra.

**Papago Point**—A branch tribe of Pima Indians of southern Arizona region.

**Pima Point**—Popular name of tribes living in the valleys of Gila and Salt Rivers, Arizona.



**Pinal Point**—An Apache tribe.

**Piute Point**—A name applied to many Shoshonean tribes, but perhaps belonging properly only to those living in southwestern Utah.

**Pollux Temple**—The devoted brother of Castor, in the Greek legends.

**Powell Plateau**—First explorer of the Colorado River, who later became director of the U. S. Geological Survey and the Bureau of Ethnology.

**Quetzal Point**—An Aztec word signifying a bird of iridescence.

**Ra, Tower of**—The Egyptian sun god, type of supreme diety, always victorious.

**Rana Shrine**—Hindu word for prince.

**Sagittarius Ridge**—A zodiac constellation visible in the southern part of the United States in summer.

**Scorpion Ridge**—One of the constellations of the Zodiac.

**Scylla Butte**—The promontory at the entrance of the strait between Italy and Sicily, around which ancient mariners feared to go.

**Set, Tower of**—The brother or son of Osiris and his deadly enemy, in Hindu mythology.

**Siegfried's Pyre**—The hero of the great German epic, Nibelungenleid. His funeral pyre forms the spectacular climax of Wagner's opera, Der Gotterdammerung.

**Shaler Plateau**—An American geologist, long-time professor at Harvard University.

**Sheba Temple**—Named for the Queen of Sheba, whose famous visit to King Solomon is related in the Bible.

**Shinumo Creek**—Name applied by Powell to the Hopi confederacy.

**Shiva Temple**—The avenging associate of Brahma and Vishnu in ruling the universe, now the most popular Hindu god.

**Solomon Temple**—The son of David and Bathsheba, king of the Jews.

**Supai Formation**—The colloquial name of the Havasupai, a small tribe now occupying Cataract Canyon.

**Thor Temple**—Second principal Norse deity, god of thunder, son of Odin, the supreme being, and Jordh, the earth.

**Tiyo Point**—Indian name.

**Tobar Terrace**—Pedro de Tovar was sent by Coronado in 1540, to inspect the Hopi villages where he learned of the existence of the Grand Canyon.

**Toltec Point**—The Toltecs were either an early tribe of the Aztecs or a people that preceded them on the Mexican Plateau.

**Tonto Platform**—Spanish word "fool" applied to the Indians of Arizona.

**Topocobya Trail**—Probably from an Aztec word.

**Unkar Creek**—A Piute tribe of southwestern Utah.

**Venus, Temple of**—The Roman goddess of beauty and love.

**Vesta, Temple of**—The Roman goddess of the hearth in whose honor the Vestal Virgins kept the symbolic fire burning.

**Vishnu Temple and Creek**—In Hindu mythology the associate of Brahma and Shiva, who was the redeemer of the universe.

**Walapai Point**—An Indian tribe in northwestern Arizona of Yuma stock.

**Walhalla Plateau**—The great hall of the Scandinavian gods, the warriors' heaven of the Vikings.

**Wheeler Point**—An Army officer in charge of surveys in the Grand Canyon region in 1872-1879.

**Wotan's Throne**—The chief deity in German mythology.

**Yaki Point**—Probably a version of the name of the Yaquis, the unconquerable tribe of northwestern Mexico.

**Yavapai Point**—These Indians are commonly known as the Apache Mo-have, formerly roaming central Arizona.

**Yuma Point**—Great family of Indians of several tribes in the lower Colorado region.

**Zoroaster Temple**—Founder of the ancient religion now represented by the Guebers and Parsees of Persia and India.

**Zuni Point**—The Zuni pueblo south of Gallup, New Mexico, is the remnant of the historic Seven Cities of Cibola.















